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Automotive Development Changes Agricultural Picture

By Charles Deere Wiman
President, Deere & Company

AGRICULTURE is America's basic industry. No matter how far we may be removed from the farm, fundamentally speaking, we are dependent upon it, not only for our food and clothing materials, but also for our business welfare and prosperity. Commerce and industry must have the new annual wealth that is produced by agriculture if they are to flourish and prosper. Naturally, the greater the volume of this wealth, the greater the volume of general business.

Agriculture from the beginning of time to the introduction of the machine on the farm, was one of the most static undertakings of mankind. It was not until the machine was introduced that any substantial changes were made in agricultural methods.

It is interesting to trace the changes that have come about through the mechanization of agriculture. (Fig. 1.) In 1820, 83 per cent of all gainfully employed persons in the United States were engaged in agricultural pursuits. In that year, 70 per cent of the average family budget was spent for food and clothing and only 30 per cent was available for the purchase of shelter, fuel, light, and all other goods and services. The result was that 43 workers per 1000 population were gainfully employed outside of the farm, while it took exactly five times that many to produce food and clothing materials.

Machine Changes Farm Picture

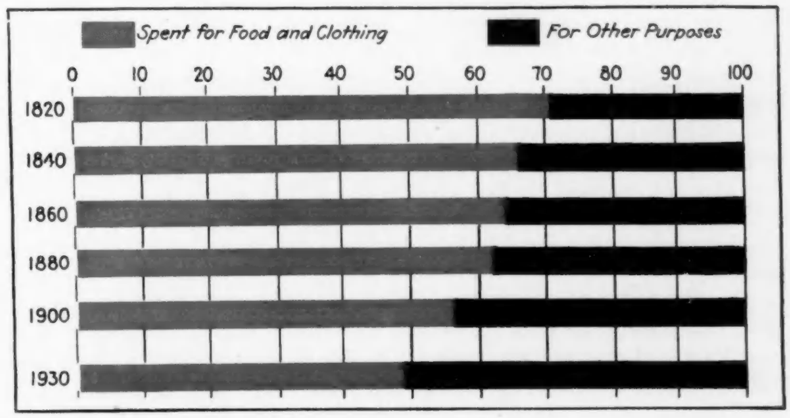
Then came the invention of the reaper which was followed by the steel plow and various types of seeding, tillage, harvesting, and other farm machinery, and the picture was completely changed. These machines so increased the productive capacity of the farm worker that by 1880 only 44 per cent of all gainfully employed workers were in agriculture. In that year only 62 per cent of the average family budget was spent for food and clothing and 38 per cent was available for the purchase of other goods and ser-

[This paper was presented at the Semi-Annual Meeting of the Society, White Sulphur Springs, West Va., June 19, 1935.]

Effect of Farm Mechanization on Employment in Other Industries

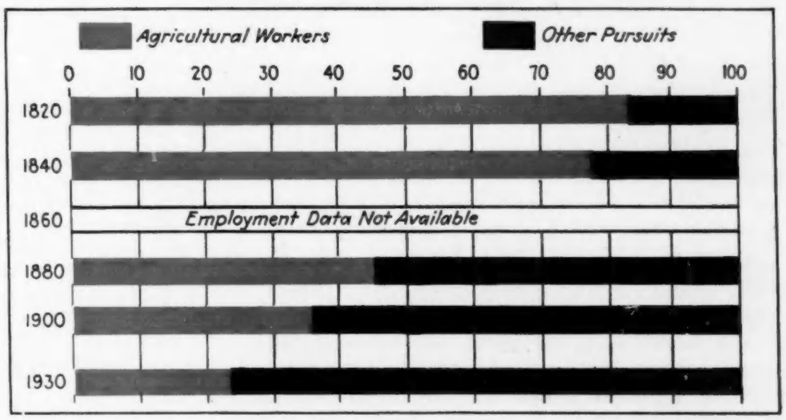
How Average Family Budget is Expended

(From Bemis on "Shelter")



Workers Engaged in Agricultural and Other Pursuits

(From Misc. Pub. No. 157 U. S. Dept. of Agriculture)



Research Dept., Farm Equipment Institute, Chicago, Ill.

Fig. 1

vices. The increase in employment in supplying these was about three and one-half times the number required in 1820. This increase was due, in large part, to the mechanization of agriculture.

In 1901 the first tractor was sold to a farmer, and this new type of power was destined to make still greater changes. In 1929, it required only 85 workers per 1000 population, or 21½ per cent of all gainfully employed, to produce food and clothing materials—a decrease of about 45 per cent from 1880 and 60 per cent from 1820. In 1929, only 49 per cent of the family budget was spent for food and clothing and 51 per cent—or more than half—was available for the purchase of other things.

33,000,000 Jobs Created by Machine

When only 30 per cent of the family budget was available for the purchase of goods and services other than food and clothing, only 43 persons per 1000 population could find employment in supplying these things, but when 51 per cent was so available, employment in these undertakings jumped to 312 workers per 1000 population—or an increase of 625 per cent. The total increase in employment in undertakings supplying goods and services other than food and clothing material between 1820 and 1929—just a little more than a century—as a direct result of the mechanization of agriculture, reaches the enormous total of 33,000,000 people.

These millions of workers man our factories, run our transportation lines, mine our coal and iron, build our automobiles, airplanes, trucks, and tractors, operate our stores, offices and banks, and render the countless other services demanded by the people. It is these people released from the soil who have developed our mammoth industries, built our wonderful cities, established our great colleges and universities, made our amazing discoveries in the arts and sciences, and brought America to her present pre-eminent position.

The high standard of living in America, where the most humble daily enjoy comforts and conveniences which were undreamed of two or three centuries ago, is the direct result of the emancipation of these millions, through the use of farm machinery, from the stern necessity of producing their own food and clothing materials. The automobile, airplane, radio, talking picture, telegraph, telephone, electric light, and the thousand other devices we are prone to consider commonplace, became possible only when the farm machine enabled a minority of the people to produce an adequate and dependable food supply for those who were devoting their attention to the development and production of other things.

It is really startling to contemplate a readjustment of employment in the United States, based upon a return to conditions which existed in 1820. (Fig. 2.) If, in 1929, it had required 215 agricultural workers per 1000 population, as it did in 1820, then we would have had 26,000,000 workers producing food and clothing material instead of the 10,000,000 we actually did have, and further, if the people would have required only 43 workers per 1000 population to supply them with all the other goods and services they could purchase, there would have been only 5,000,000 of these. This would account for a total employment of about 31,000,000, and we would have 17,000,000 permanently unemployed.

Machine Increases Productive Capacity

One of the principal objectives of a machine is to increase the productive capacity of its user. Nowhere else is this more important than in the case of agriculture. The farmer, unlike the industrial worker whose compensation is in the form of a fixed wage or salary, puts his labor into the production of his product, and when he sells the product the rate of his pay is determined. Obviously, the more units of production per hour of his labor, the higher will be the rate of his pay. The machine reduces his hours of work and automatically increases his rate of pay.

In April, 1933, the U. S. Department of Agriculture issued a bulletin which gives us some interesting data on the effect of mechanization on agriculture. According to this document, the approximate labor requirements for major operations in the production of an acre of wheat, yielding 20 bushels, in 1830, was 57.7 man-hours; in 1896, 8.8 hours; and in 1930, using tractors, gang plows, grain drills, combines, and motor trucks, 3.3 hours. If wheat had been worth $1 per bushel in each of these years, or $20 per acre, it is easy to see that the 1830 farmer would have received a gross return of about 35 cents an hour for his labor; the 1896 farmer $2.27; and the 1930 farmer, for each hour he worked, had a gross return of $6.06.

Let me apply these data on hours to actual yields and prices in 1896 and 1932, respectively. In 1932 the average farm price of wheat was the lowest on record and was less than one-half the price in 1896. Yet, the 1932 farmer who raised his wheat by 1930 methods received a gross return per hour of his labor approximately 40 per cent greater than the 1896 farmer. In 1896 when it took 8.8 hours of man labor to grow and harvest an acre of wheat, the average yield was 12.4 bushels per acre; the average farm-price 71.7 cents per bushel, and the average value of an acre of wheat was $8.89. The gross return was $1.01 per hour. In 1932 when an acre of wheat could be grown and harvested with 3.3 hours of man labor, the average yield was 13.2 bushels per acre; the average price was 35 cents per bushel, and the average value of an acre of wheat was $4.62; the gross return per man hour of labor was $1.40.

Machines Protect Farm Prices

Had the 1932 farmer been growing wheat by 1896 methods —and a great many of them actually were—the gross return per hour of labor would have been 52½ cents instead of $1.40. Properly selected machine methods of operation are the farmers' most reliable protection against destructive low prices.

Wonders have been accomplished through mechanization in reducing costs of production on American farms, but there still is much to do. Less than one-sixth of our farms use tractors and more than 5 million farmers are still using methods not greatly different from those of the "Nineties." Obviously, there are too many hours of man-labor going into the production of farm products in this country.

In 1930, according to the 1932 "Year Book of Agriculture", the average cost of growing and harvesting an acre of corn in the Corn Belt, exclusive of land rent, marketing and credit for fodder or stover, was $13.96. That same year (1930), figures were collected from 47 representative tractor farmers, located in 14 different states, whose corn acreage ranged from 20 to 200, and whose yields ranged from 20 to 75 bushels per acre, with averages approximately the same as the average for the entire Corn Belt. The costs of these farmers averaged $6.85 per acre, exclusive of land rent and marketing, or $7.11 less cost than the average for the entire Corn Belt as shown by the Year Book figures.

The importance of such mechanization by all farmers be-

comes more apparent when we apply this possible saving, due to tractor farming, to the 100,000,000 acres of corn which were harvested in the United States that year, and realize that the total saving would have amounted to about $700,000,000.

Figures also were collected from representative wheat and cotton growers who operated with tractors, and contrasted with "Year Book" estimates of average costs. The comparison indicated a possible saving of about $300,000,000 in the cost of raising the 1930 wheat crop and $700,000,000 on the cotton crop, and a grand total of $1,700,000,000 savings on the corn, wheat, and cotton crops of 1930, through the use of tractors and power equipment. This saving is equivalent to 15 per cent of the average gross farm income for the five-year period—1925 to 1929.

Transition from man to animal power in agriculture was a slow process. The pioneer machine builder was confronted with many obstacles.

But these pioneers persevered in their efforts and finally mechanization swept American agriculture.

Power Farming Age Dawns

At about the beginning of the 20th Century, a new era in agriculture was introduced, an era that was destined to make still greater changes. It was the beginning of the development of the tractor which substituted mechanical for animal power. While it took nearly 70 years for horse-drawn machines to increase the efficiency of agricultural workers, 57 per cent over the 1820 standard, the tractor and other power farming equipment, coupled with improvements made in other types of farm machines, raised the efficiency of the farm worker 60 per cent between 1900 and 1930. This was a total increase in efficiency from 1820, of 153 per cent.

Rough and rugged was the path of the pioneer tractor builder. Sales were few and far between. People everywhere were doing their best to discourage farmers from buying, and it took years for the tractor builder to accumulate the experience that might have been gained in a much shorter time had his product met with such a ready market as did the automobile. In 1916—15 years after the first tractor was sold—production was still under 30,000 units. That year there were 1,526,000 passenger cars and 92,000 motor trucks —a total of 1,618,000 units—turned out by the automotive industry.

While many of the problems of the pioneer automobile and tractor builders were identical, the tractor man had many that were all his own.

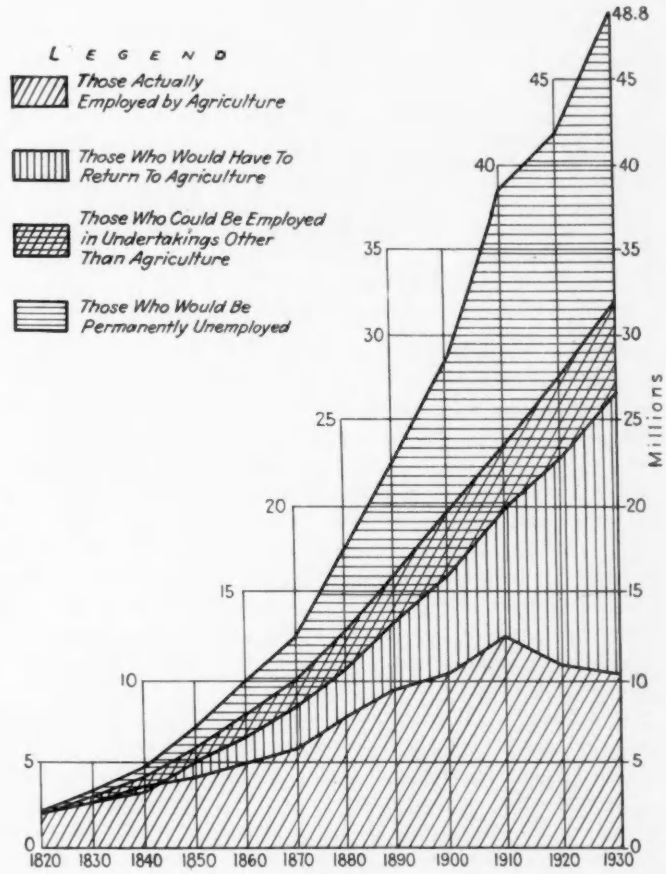
With its first objective to supplant the horse in the field, it was only natural that the early tractor builder should design his machine principally for draw-bar operations. The early tractors were big and cumbersome machines, more a resemblance of the early-day locomotive than of the modern tractor. So heavy were they that a major portion of the power developed by their engines was required for self-propulsion.

Tractors Cut Farm Costs

But despite their size and crudeness, these early tractors on large farms performed farm tasks at costs so far below anything that ever had been accomplished with animal power that it was evident to anyone of vision that they were destined to gain wide popularity. That they were too big for existing farm acreages in most parts of the country was evident, and much talk was heard about increasing the size of the farm

Theoretical Readjustment of Employment in the United States

Based on Return of 1820 Conditions Prior to Advent of Farm Machines



Research Dept., Farm Equipment Institute, Chicago, Ill.

Fig. 2

unit to adjust it to the size of the tractor. Of course, such a theory was impracticable and finally tractor designers started building the tractor down to the size of prevailing farms.

The power take-off was added, the size and power of the tractor was reduced, excess weight eliminated, and finally, it was redesigned in what is called the "general purpose" type which carried, rather than pulled, many of its implements. These new models, adapted to row crops, met with the hearty approval of farmers and the industry got into full swing in the late twenties, only to be slowed up by the collapse of agriculture in 1930.

During the depression, manufacturers undertook another job of building down the tractor to fit even smaller-sized farms and the so-called one-plow unit was placed on the market. The size was adapted to the power needs of some 2,000,000 farms which, prior to its advent, were too small for economical operation of the then existing tractors.

The economies in crop production costs accomplished by the general purpose tractor almost surpass human belief.

With it almost every farm job is being done in shorter time and with less expense than ever before was possible.

Crop Land Increase Not Due to Tractor

The statement frequently is heard that tractors and other power-farming machinery have been responsible for opening up new lands, increasing crop production, and creating destructive surpluses. The records of the U. S. Bureau of Census do not bear out this contention. In the 20-year period between 1880 and 1900, before a single tractor had been sold to a farmer, 116,000,000 acres were added to the National total, while in the 30-year period between 1900 and 1930, only 75,000,000 were added. This latter increase did not begin to keep pace with our growth in population as is evidenced by the fact that in 1900 we were harvesting 3886 acres of crops per 10,000 population while in 1929 we harvested only 3028 acres.

Many Problems Confront Industry

Few, if any other, manufacturers have as many problems to solve as does the builder of farm equipment. In addition to the usual ones of production and factory operation, there are many peculiarities in our business that are not found in others. Among these might be mentioned the fact that varying soil, climatic and crop conditions in different parts of the country make it necessary for us to supply special types of equipment for each particular condition. This is not merely to suit the whims of farmers, but because machines which operate satisfactorily in one section may not do so in another. This fact interferes with the setting up of big production schedules of identical machines, which, as is well recognized, is one of the surest ways to reduce costs that is known to manufacturers. Then there is a fluctuating demand for our product, varying as much as 50 per cent in successive years, which frequently results in loss of business through shortage of merchandise or losses from excessive carry-overs. It is an almost daily occurrence for implement manufacturers to supply repair parts for machines which have been out of production 15 or 20, or even 30 years.

Despite these difficulties, all of which add materially to production costs, our industry has been able to maintain a level of prices as low, and sometimes even lower than prevail in other industries where there are far fewer complications in their operations. We have been unable to find a single manufactured product made out of iron and steel and lumber, and produced in similar quantities, which is sold on as low basis per pound as agricultural implements.

When tractors are compared with automobiles, it is well to remember that the tractor must operate most of the time at near-peak loads and under the most trying conditions found in field work. This fact makes it imperative that every part of the tractor be designed to stand tremendous stresses. It is not possible, in tractor building any more than it is in automobile building, to cut corners to save costs but rather it is necessary to build to required strength regardless of how the ultimate price is affected.

The modern tractor, with a reasonable amount of maintenance, is capable of giving continuous service through ten 1000-hour years, even under the severe conditions to which it is subjected. This is equivalent, on the basis of the number of crankshaft revolutions, to 195,000 miles at 40 miles per hour by one of the popular low-priced automobiles. When the farmer buys a tractor he may safely expect that it will operate under heavy load the equivalent of 195,000 automobile miles.

One advantage the automobile builder holds over the tractor manufacturer when it comes to prices is that of volume. In the tractor industry there is no such word as "volume" as used by the motor-vehicle manufacturer who speaks in terms of millions per year. There is quite a definite limitation to the possible number of tractors that can be sold in this country. That limitation comes from the number of farms. There are only 4,600,000 farms in the United States capable of using tractors and in that number are included one-half of the farms between 20 to 49 acres and all of the farms larger than 49 acres, regardless of topography or whatnot. Of these 4,600,000 farms, about a million already use tractors, leaving only a possible future sale of 3,600,000 units in addition to replacements. If the tractor industry were to build as many units as probably will be produced by automobile and motor-truck manufacturers this year, every tractor plant in the country would have to remain closed for the next 10 years, except for such operations as would be required to supply replacements. Replacements could not exceed 400,000 units per year if all possible farms in the United States were tractorized.

Implements Improve Living Standards

In closing, I want to quote from the December, 1934, Review of the National City Bank of New York, in which I find the following:

"It is assuredly true that the development of the implements of agriculture and of the means of transportation across continents and seas, has done more to ameliorate and improve the living conditions of the masses of mankind than all other developments of the time together because all of the other developments were dependent upon a release of labor from primary needs."

Amendment and Addition to By-Laws

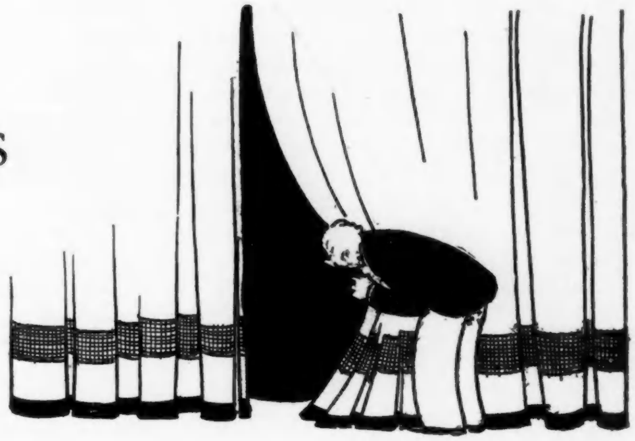
At the June 16, 1935, meeting of the Council, in accordance with Paragraph C-57 of the S.A.E. Constitution, By-Law B-39 was amended to add the Tractor and Industrial Power Equipment Professional Engineering Activity to the list embraced in the previous wording of the By-Law.

Paragraph B-48, an addition to the By-Laws, reads as follows:

"Members of the Society shall not seek to influence the nomination or election to any office of the Society of either themselves or any other member, by commercial pressure, campaigning or other form of political activity. Any member who, in the judgment of the Council, shall violate this section may be expelled from membership by vote of two-thirds of the total members of the Council, provided that the member shall have been given written notice of the charges and an opportunity to defend himself."

Behind the Scenes

With the Committees



Standards Report Approved

THE regular Semi-Annual Meeting of the General Standards Committee was held on June 17 and received reports from five Divisions on 17 subjects, from among about 125 that have been before the various Divisions of the Standards Committee during the past half year. During this time several Divisions, notably the Lighting and Production Divisions, have reviewed existing standards in the S.A.E. HANDBOOK, or as published separately, that come within their scope, with the purpose of bringing them up to date or cancelling those that are obsolete. Among the more important subjects acted on were revisions in the standard laboratory tests for electric headlamps, the cancellation of several obsolete lighting specifications, revisions by the Parts and Fittings Division in the S.A.E. Standard for Fuel and Oil Tube Fittings and proposed revisions in the present standard for Taps. One important recommendation by the Production Division that was approved is the consolidating and republishing of certain of the Production Standards that have been published separately from the HANDBOOK, and their inclusion in future editions of the HANDBOOK. This means that from now on all the standards and recommended practices officially adopted by the Society will be included in the S.A.E. HANDBOOK.

The reports of the Divisions as passed upon by the General Standards Committee were reported to the Executive Committee of the Council on Wednesday and approved as submitted. Further information on these and other projects before the Standards Committee will be published in subsequent issues of the S.A.E. JOURNAL, but no new edition of the S.A.E. HANDBOOK or SUPPLEMENT to it will be issued at this time.

Notice of Cancellations

Notice is hereby given to the members of the Society and others that the following standards and recommended practices have been cancelled and discontinued, the page reference in each case being to the 1935 edition of the S.A.E. HANDBOOK. The cancelled specifications are Dome Light Lamp Sockets, p. 132; Headlamp Mountings, pp. 119 and 120; Motorcycle Headlamp Mounting, p. 120; Tail and Signal Lamp Mountings, p. 121; License Plate Bracket Slots, p. 121; Lamp Lenses, pp. 122 and 123; Headlamp Construction, pp. 619 and 620; Motor Vehicle Acetylene Headlamps, p. 621; Tail Lamp Construction, p. 622; Lamp Nomenclature, pp. 673 to 675; Plug and Ring Gages (as separate publication) and T-Slots, Bolts, Nuts, Tongues and Cutters (published separately).

The following standards, at present published separately, will hereafter be included in the S.A.E. HANDBOOK: Plug and Ring Gages, Taps for Cut and Ground Threads (as now being finally revised) and Woodruff Key-Slot Cutters and Gages.

C. W. Spicer, chairman of the general Standards Committee, presided at its White Sulphur meeting.

Ignition Research

IN view of the fact that the Federal Specifications Board has issued a tentative proposal for efficiency testing of sparkplugs, it was suggested at the June 16 meeting of the Ignition Research Subcommittee that the Subcommittee be disbanded as its principal interest would be covered by the Federal specification. The research executive committee, however, at a subsequent meeting recommended that the Ignition Research Subcommittee be continued due to the fact that there is unfinished business before it in the form of an expected report on the work sponsored at the National Bureau of Standards.

Motor Coach and Truck Rating

ONE of the recommendations agreed upon at the National Conference on Street and Highway Safety in Washington, D. C., last year was that a standard method of rating motor-truck performance ability as one of the factors for regulating the operation of motor trucks on highways be adopted. The purpose of this recommendation was to establish a uniform basis on which motor trucks could be operated safely on highways in normal traffic conditions. At that time it was agreed that the performance ability should be a minimum speed of 20 m.p.h. on a 3 per cent grade in level country and on a 6 per cent grade in hilly country.

This recommendation was brought to the attention of the Council of the Society as a matter of direct importance to the automotive industry and the Council thereupon reestablished the S.A.E. Motor-Truck and Motorcoach Rating Committee to continue its study of this subject. At the Committee's meeting on June 18, the report of the previous Committee that was published in the March and April, 1933, issues of the S.A.E. JOURNAL was discussed and taken as the basis for a new proposal of a motor-truck performance ability formula. A previous survey of the Committee's original recommendation

had shown that it was too comprehensive for general acceptance and use by motor truck manufacturers and operators and accordingly it was agreed to base a new recommendation on a simplification of a previous report.

A Subcommittee under the chairmanship of M. C. Horine was appointed to prepare a report to be circularized by Chairman L. R. Buckendale for review and a check against the current practices in this connection of motor truck manufacturers and operators. It is expected that this review, together with criticisms and suggestions bearing on the Committee's present recommendation will enable the Committee to formulate a definite recommendation for early consideration by the Council of the Society.

E. P. Lubricant Testing Machines

ARRANGEMENTS for the production of 20 extreme-pressure lubricant testing machines have been completed and it is expected that acceptance tests on the machines will have been run off by the time this issue of the S.A.E. JOURNAL goes to press. S. A. McKee of the National Bureau of Standards was delegated to conduct the tests, at a meeting of the E. P. Lubricants Research Subcommittee held at White Sulphur, June 20. The machines were produced at the plant of the Highway Trailer Co. and tests were to be conducted at Edgerton, Wis. On completion of the acceptance tests the Subcommittee plans a meeting at Edgerton to consider results of the tests and the question of releasing machines for experimental use.

The program for preliminary tests to be undertaken by the laboratories which have agreed to purchase the first 20 machines includes 7 of the original 10 types of lubricants tested by the National Bureau of Standards. Two one-gallon samples of each lubricant will be shipped to each laboratory so that they will be received concurrently with the machine and a copy of the proposed test procedure which has been outlined by a special subcommittee. Exchange of data secured in the preliminary tests will, for the present, be confined to the active participants in the cooperative undertaking.

Truck, Bus and Railcar Plans

AT the meeting of the Truck, Bus and Railcar Activity Committee on June 17, the plans for a fall Transportation Meeting as discussed by the Transportation and Maintenance Activity at its meeting on the same day were outlined by A. M. Wolf, Chairman of the T. & M. Meetings Committee, as given in the report of the T. & M. Activity Committee's meeting. As the original discussion of a fall Transportation Meeting and its program had been on the basis that it would be under the joint auspices of the two Activities, the Committee discussed the subjects reported for the T. & M. Committee, together with several others and finally concurred in the programs as proposed at the T. & M. Activity Committee Meeting, the details of which are to be arranged for by Chairmen Buckendale and Wolf.

The Committee also discussed briefly plans for a T., B. & R. Session at the Annual Meeting of the Society next January, detail arrangements for which were referred to Chairman Buckendale. Further announcements of the programs for both of these meetings will be published in subsequent issues of the S.A.E. JOURNAL.

Oiliness Research

ENGINE tests to determine whether or not it is possible to show an advantage in the use of oiliness agents as an addition to mineral oil under engine operating conditions will be run off by interested laboratories under a procedure set up by the Oiliness Research Subcommittee which met at White Sulphur during the week of the Summer Meeting. By a comparison of data the Subcommittee will attempt to determine whether or not a reduction in engine wear can be shown as a result of using oiliness agent additions, piston ring wear being the principal criterion.

General agreement has been reached both as to the best oil to be used and the oiliness agent additions, i.e., non-commercial products that will serve to bring out the differences between a base oil and the same oil with an oiliness addition.

The Research Committee has approved the program as outlined and recommended that the present tentative organization with J. B. Macauley as chairman by establishing formally as a Research Subcommittee.

Every laboratory cooperating in the project will be requested to run tests on its own type of equipment in order to provide a variety of conditions and it has been suggested that it would be of interest to have a Diesel engine included in the tests.

Riding Comfort Research

AN exhibit of instruments developed for riding comfort was held at the Summer Meeting of the Society under the auspices of the Riding Comfort Subcommittee and through the cooperation of several of its members. At a meeting on June 19, the Subcommittee approved a memoran dum on "The Essential Characteristics of Instruments to Measure Riding Comfort" which appears in extended form with illustrations on pp. 20 to 23 in this issue of the S.A.E. JOURNAL.

Safety Standards for Lamps

IN April this year, a general conference was held under the auspices of the American Standards Association and participated in by representatives of the Society, to decide whether a general code for inspecting automobiles in use should be developed. The primary purpose of such a code would be to foster uniform inspection of vehicles in use by the administrative officials of the States, but not the inspection of vehicles in manufacture. The conference decided that the project was desirable, and as this matter is considered one largely of automotive engineering, the Lighting Division was asked by the S.A.E. Highway Research Subcommittee, which had been working on several related subjects, to recommend a set of headlight beam position limits that would be suitable in such a code. The Division appointed a Subdivision, of which P. J. Kent is Chairman, to determine facts by test and otherwise, on which to establish such limits. A meeting of the Subdivision was held recently in Detroit, and preliminary tests made according to a tentative recommendation that was drafted at the Lighting Division meeting in May.

A number of cars were equipped with headlamps adjusted to meet the tentative beam position limits, and driven to the Semi-Annual Meeting for demonstration runs before the Committee completes its report. Members of the Highway Research Subcommittee and a number of others made short runs

on Tuesday night over the mountain roads, and their observations and opinions were discussed by the Subdivision at its meeting on Wednesday. A revised report was drafted that confirmed the previous tentative recommendations to a large degree, and this will be sent to the Lighting Division for approval. As the Motor-Vehicle Lighting Committee of the Illuminating Engineering Society has for many years cooperated with the Division in automobile lighting matters, the report will be sent to it also for their opinion before it is finally referred to the Highway Research Subcommittee, which in turn will refer it to a Sectional Committee that it is expected will be organized under the procedure of the A.S.A. to eventually prepare a complete code for inspecting automobiles that are in use. The Society expects to take an active part in this entire program.

Crankcase Oil Stability

EACH member of the working group of the Crankcase Oil Stability Research Subcommittee has been requested to supply the chairman with a written report of the test methods and results which he has secured on the evaluation of oils for crankcase oil stability, in order that these reports may be circulated among the members of the Subcommittee.

It is understood that these data on used oils will be formulated by the individual members in terms of test methods discussed at a meeting on June 21, and that each report will be accompanied by recommendations for a program to continue the work on a cooperative basis.

The Subcommittee in its discussion agreed upon the desirability of having 2 sets of test figures on oils, i.e., before and after use as to the following values: naphtha insoluble; chloroform soluble, and a modification of the Navy Work Factor Method whereby new oil is taken as 100 per cent work factor and a used oil qualified by a change in viscosity, neutralization, Conradson carbon, and precipitation number.

T. & M. Sets Meeting Plans

THE Transportation and Maintenance Activity Committee has completed plans for the Transportation Meeting of the Society next fall and for the Transportation and Maintenance Session at the Annual Meeting of the Society next January. One of the most important decisions reached was that the Transportation Meeting next fall be under the joint auspices of the Transportation and Maintenance Activity and the Truck, Bus and Railcar Activity of the Society. It was also decided that this meeting should cover only one day of two technical sessions and that it should be held in Chicago on Oct. 10 immediately preceding the S.A.E. Tractor and Industrial Power Equipment Meeting there on Oct. 11 and 12, the arrangements for which have been nearly completed by the Tractor and Industrial Power Equipment Activity of the Society.

More detailed information on the topics of papers to be presented and other details of the meeting will be published in subsequent issues of the S.A.E. JOURNAL.

The Committee also planned for the usual Transportation and Maintenance Session at the S.A.E. Annual Meeting next January, the feature of which will be a continued report on "Motor-Vehicle Design from the Operation and Maintenance Standpoint" that has been under study for some time by a Subcommittee under the chairmanship of F. L. Faulkner and on which two reports of general interest and importance had been discussed at previous meetings of the Society.

The Committee elected Austin M. Wolf to serve on the T. & M. Nominating Committee which is to select a consenting nominee for Vice-President in charge of Transportation and Maintenance Engineering during the year 1936.

Chairman T. C. Smith presided at the Committee meeting.

Highways Research

THE Highways Research Subcommittee, Chairman T. C. Smith reported to the main Research Committee at its White Sulphur meeting, is well past the formative stage in its undertaking to provide a technical basis for limits and test methods for the use of enforcement officials in states and municipalities that have instituted compulsory motor-vehicle inspection.

A meeting of the Subcommittee in New York on June 3 drew a large and representative attendance which included enforcement officials from the Eastern group, representatives of the National Bureau of Casualty and Surety Underwriters, the National Bureau of Standards, and the other committees of the Society which are cooperating on various phases of the project, notably, the Brake Committee, the Front Wheel Alignment Research Subcommittee and the Lighting Division of the Standards Committee.

Aviation Gasoline Detonation

THE C. F. R. Aviation Gasoline Detonation Subcommittee met at White Sulphur Springs on June 17 to receive the report of the Steering Committee appointed to direct the full-scale engine tests and to analyze the results.

The conclusions indicate that not only are ratings by the C. F. R. Motor Method in substantial agreement with engine results in the case of the straight-run gasoline plus lead but also in the case of the cracked gasoline plus lead. On the basis of the conclusions and recognizing the imminent possibility of aviation fuels of higher knock rating than the best fuels included in the tests, i. e., above 87 octane number, the Steering Committee recommended that no attempt to modify the Motor Method as applied to aviation gasoline be made in the interest of better correlation until data have been obtained for the higher octane ratings.

The A. G. D. Subcommittee in approving the report noted the fact that there are other types of cracked gasoline which possibly might behave in a different manner from the single cracked gasoline included in the tests and, therefore, recommended obtaining some data on additional samples and if possible including these results in the more complete report to be presented to the Cooperative Fuel Research Committee at its regular September meeting.

Research Regulations Approved

THE Society's Council at its meeting on June 16 approved the Research Committee Regulations under which the Research Committee, its subcommittees and the Research Executive Committee have been operating for almost a year, and which were officially endorsed by the Research Committee at its January, 1935, meeting.

Criteria Are Set for Riding Comfort

By R. W. Brown

In Charge of Research Engineering, Firestone Tire & Rubber Co.

and

Dr. H. C. Dickinson

Chief, Heat and Power Division, National Bureau of Standards

RECENT efforts to summarize various riding comfort investigations have resulted in the evolution in experimental form of two very practical types of instruments. Two new instruments have been constructed and used extensively for routine measurement of riding comfort.

Heretofore extensive measurements of riding comfort have been handicapped apparently by the laboratory nature of the numerous instruments which research has brought forth. Commercial development of instruments has been delayed pending the segregation of essentials from voluminous research data. These "missing links" have now been "forged" and are presented with descriptions of practical applications.

Essential Instrument Characteristics

After careful consideration of all pertinent information, the Riding Comfort Research Subcommittee has arrived at the following essentials as a basis for the practical measurement of riding comfort:

1. The measuring instrument should be actuated by the forces which occur between the occupant of the vehicle seat and the upholstery of the seat. Conceivably this might be accomplished by using a "dummy observer" resembling a human being in shape and weight distribution, or by using some sort of indicator, such as a pneumatic cushion, between the subject and the upholstery.

2. The instrument should make an integrated record of the accelerating forces and the total time of application of these forces, exclusive of the static forces.

3. As an alternative, the instrument should record preferably the total number of times the accelerating force exceeds some predetermined limit.

4. The instrument should be adjustable so that the relative effects of forces of different periods and intensities can be taken into account in the system of interpolation, so that finally an integral result can be had which matches the average result obtained with a large number of observers.

5. The record should be a single integral figure for any given length of road or length of time, both as to (2) and (3).

6. The vertical forces on the seat and the pitching, or fore and aft forces, on the back should be recorded separately, probably on separate instruments. Transverse forces might be measured, if desired, by the same sort of instrument used for the back, but this might require some special type of car seat since there is no fixed position from which to start in the transverse direction.

7. The instrument or instruments must be so designed and constructed as to be capable of calibration in terms of known fundamentals. Static calibrations will be acceptable provided they are fully substantiated by investigation of dynamic properties throughout the operating range.

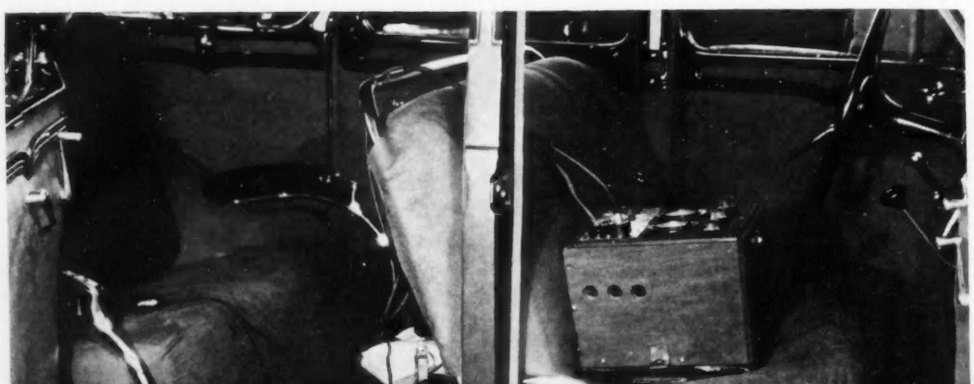


Fig. 1—Chrysler accelerometer for measuring riding qualities of vehicles.

This instrument, placed in the seat of an automobile upon a suitable base, gives a single integrated time reading of the vertical and (longitudinal) horizontal accelerations produced by reactions with the seat cushion and back.
Also, the accelerations in either direction may be recorded independently. Adjustments are provided for measuring any arbitrary relationship of the forces and their resultants in two planes. A zero adjustment permits of varying the minimum acceleration recorded.
The pick-up of the instrument is extremely sensitive to all impressed forces, although its calibration is remarkably constant and may be checked on the road if desired by a simple gage furnished with the instrument.

Research; New Instruments Made[1]

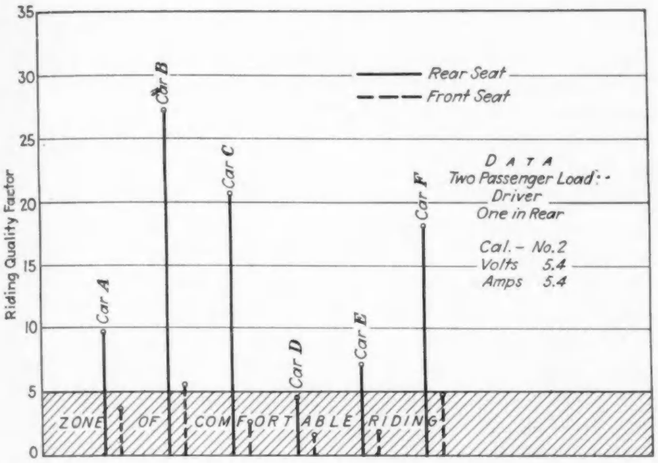


Fig. 2—The integrating accelerometer used by C. A. Tea gives a single time reading for vertical and horizontal accelerations affecting the passenger

8. Compact, small-size, light-weight instruments are desired, suitable for use in motor vehicles. Various types, if electrically operated should be suitable for operation on a 6-volt conventional motor-vehicle battery.

9. Provision should be included for simple field checking of the zero or other known point on the scale.

10. The instrument should be of such simple design and construction as to permit its usage by one operator in road service.

Practical Applications

C. A. Tea[2] has developed and used for some time an integrating type accelerometer (Fig. 1) which incorporates a majority of the essential requirements outlined. This instrument, placed in the seat of an automobile upon a suitable base, gives a single integrated time reading (Fig. 2) of the vertical and (longitudinal) horizontal accelerations produced by reactions with the seat cushion and back. Accelerations in either direction may be recorded independently.

Adjustments are provided for measuring any arbitrary relationship of the forces and their resultants in two planes. A zero adjustment permits of varying the minimum acceleration recorded.

The pick-up of the instrument is extremely sensitive to all impressed forces, although its calibration (Fig. 3) is remarkably constant and may be checked on the road if desired by a simple gage furnished with the instrument.

Dynamic calibration is realized through suspending the entire instrument on a long spring and timing the resulting vibration when released from any predetermined tension. From the frequency the equation for acceleration is obtained: $a = \frac{(2\pi f)^2 r}{43{,}200}$ (r being in inches). Three different springs having frequencies of 49.6, 67.1 and 87.8 cycles per minute are ordinarily used.

Static calibration may be performed by adding weights to the accelerometer mass. The contact gap opening produced by this addition is measured accurately by a micrometer screw. The second step in this calibration requires the measurement of the time for the accelerometer weights to close the gap from each weighted position. This is accomplished with a relay and registered on the indicating dial.

The forces to which the passenger is subjected have been measured directly by M. L. Fox[3] who inserts inflatable air cushions in both horizontal and vertical positions between the passenger and the seat cushion. One cushion is placed on the seat and the other in back of the passenger. The air pressure from the cushions is transmitted by two small rubber hose to the recorder.

The recorder contains two pressure-recording pens producing a graphical record on a single continuous strip of prepared paper. The paper is driven at constant speed by a governed electric motor and the pens arranged to produce the record of seat and back pressure variations directly over each other.

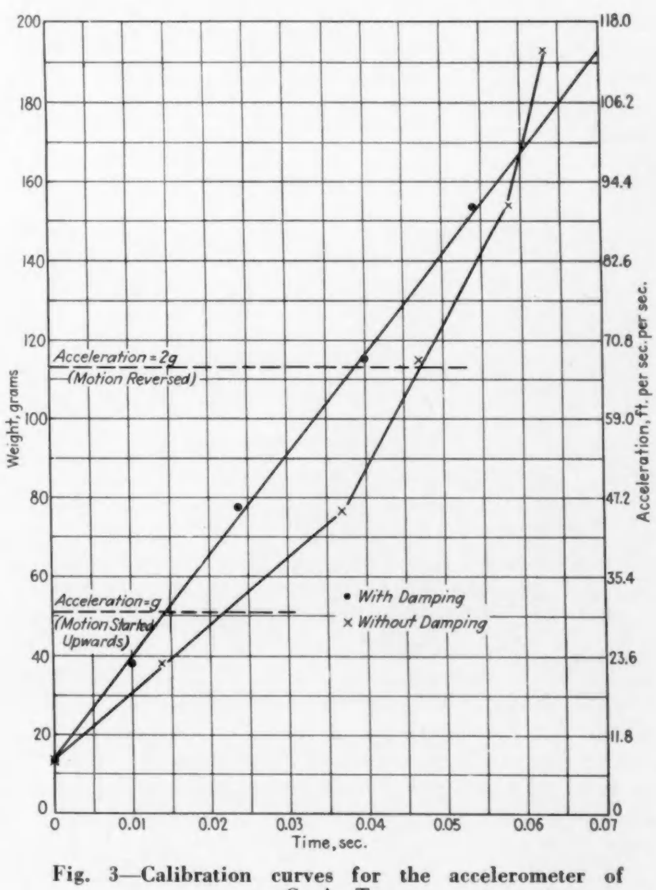


Fig. 3—Calibration curves for the accelerometer of C. A. Tea

[1] This article was authorized and sponsored by the Riding Comfort Research Subcommittee at a meeting held at White Sulphur Springs, West Va., June 19, during the Summer Meeting of the Society. Its publication is intended to show progress in the Development of instruments for the measurement of riding comfort and to stimulate experiment with them, and for the advancement of the art. Notes on other phases of the Subcommittee's activity will be found on page 18 of this issue of the S.A.E. Journal.

[2] Research engineer, Chrysler Corp.

[3] General Motors Proving Ground, Milford, Mich.

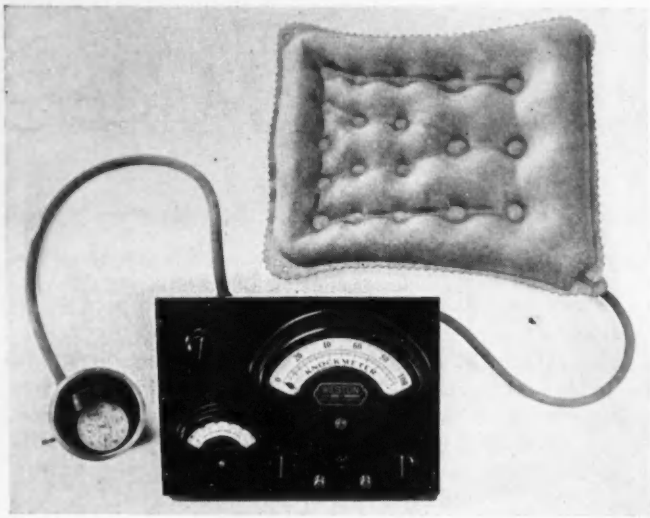


Fig. 4—National Bureau of Standards riding qualities indicator.

The pneumatic cushion may be used either on the seat cushion or on the back. The knockmeter indicates the degree of roughness experienced by the person seated on or leaning against the cushion. The dials of the anemometer (at the left of the cut) record the total amount of roughness experienced in any given trip. The whole is actuated by the passage of air back and forth through the tubing between the cushion and the anemometer box.

The records are made on transparent paper thus permitting direct visual intercomparison of records secured under similar test conditions but with different equipment.

By inspection of the records it is apparent which car gives the greater pressures against the passenger, both at the seat and back. Also, these pressures are a measure of the force exerted on the passenger by the car; they are what the passenger feels. Since the mass of the passenger is constant, these forces are a measure of the acceleration, both vertical and horizontal, transmitted by the car to the passenger.

New Instruments

A satisfactory ride-meter should not only indicate the momentary amount of discomfort or roughness, as experienced by a passenger in the car, but should also be capable of integrating the roughness over any desired interval. To be practically usable, it should present the result as a number rather than in such form as wiggles on a tape, requiring arduous labor to interpret, if interpretation be possible.

The ride-meter (Fig. 4) exhibited by the National Bureau of Standards at the recent S.A.E. Summer Meeting accomplishes these results by simple means. This ride-meter, in its present form, consists essentially of a pneumatic cushion, on which the subject sits, connected by flexible tubing through a hot wire and a vane anemometer to a constant-volume reservoir. Momentary pulsation of air to and from the cushion and the reservoir through the flexible tubing is indicated by the hot-wire anemometer, while the total flow of air is counted by the vane anemometer.

While in this instrument the sensitivity of the indicating element can be varied, that of the integrating element, the vane anemometer is of course fixed. Because of the wide variability in the roughness of different car-road combinations, it is desirable to have the sensitivity of both elements of the ride-meter adjustable over a fairly wide range, in order that measurements made under these different conditions shall have equal relative precision.

To accomplish this purpose, the ride-meter is being redesigned. In the model now being built, the vane anemometer has been eliminated. Integration of the roughness is made by a special form of electric meter. Sensitivity of both indicating and integrating elements will be coincidentally variable over a wide range.

This new instrument will measure the actual effect on the passenger, it will indicate continuously the roughness, and, in the course of a run of a minute or more, it will give the integrated roughness to three significant figures.

Efforts to use pedometers[4], notwithstanding their serious mechanical limitations, to evaluate the vibrations occurring in motor cars indicates the need for small size, rugged devices of such construction that they are very convenient to use. The development of an instrument (Fig. 5) having the desirable features of the pedometer, and at the same time meeting scientific requirements has been sponsored by R. W. Brown.

The instrument is arranged so that the movement of a spring suspended weight is totalized on the indicating dial. Since the natural frequency of the suspension can be maintained appreciably above the highest frequency that occurs on seat cushions, the unit functions as a true accelerometer. Adequate damping is inherent in the design, hence errors due to the natural frequency of the suspension are eliminated.

Acceleration is measured in a single plane. Their small size permits the use of two or more of the instruments in different planes either horizontal or vertical, or if desired, simultaneous use of a number of instruments in different positions on the front and rear seat cushions.

In former studies some difficulty has been encountered in correlating the mental and physical fatigue of the passenger with the mechanical vibrations to which he has been subjected. Small instruments offer the possibility of measuring these vibrations directly on the passenger. For example, two instruments could be placed in the horizontal plane on the passenger's lap, one on a transverse axis and the other on a longitudinal axis. A third instrument could, without too much inconvenience to the passenger, be placed on the chest to measure vertical vibration. It is even conceivable that an instrument could be worn as a hat to measure the "neck snapping" action occurring in the rear seat position.

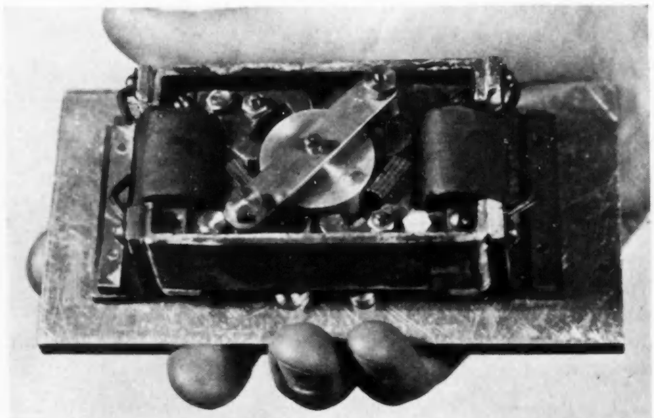


Fig. 5—Experimental integrating accelerometer.

Small size and ruggedness is emphasized in this effort to provide a commercially available practical instrument. It indicates on a dial (not shown) true integration of acceleration versus time, and promises to meet essential requirements.

[4] See S.A.E. JOURNAL, July, 1932, p. 305; "Frame Design and Front End Stability", by Clyde R. Paton.

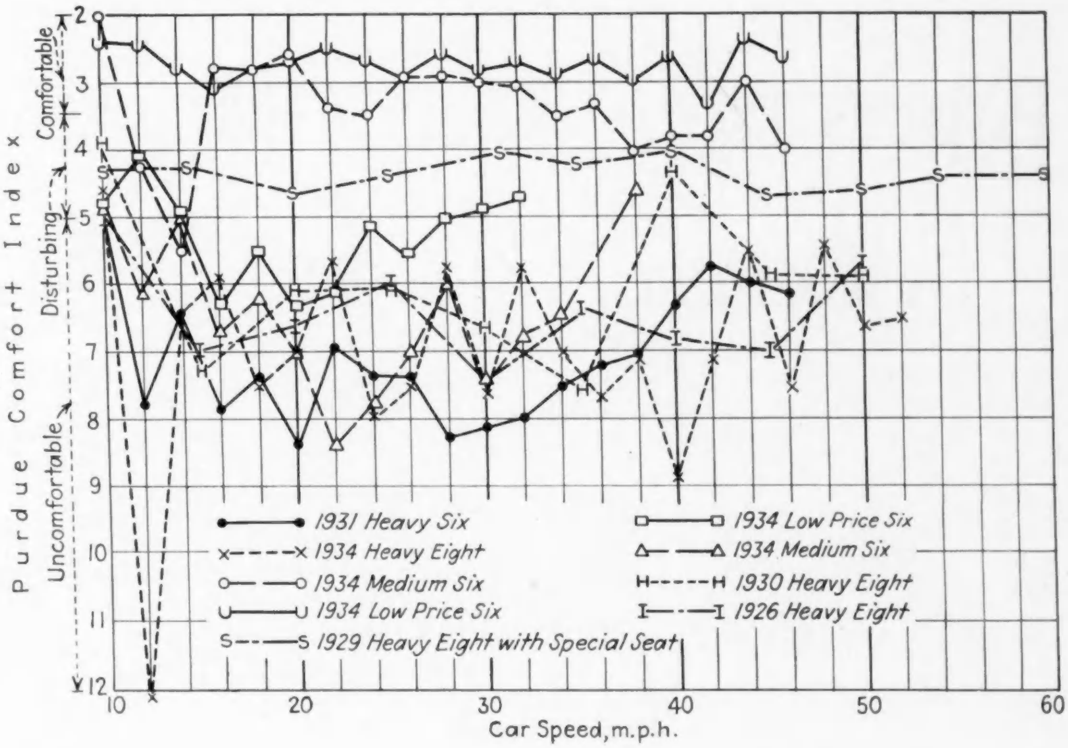


Fig. 6 — Line chart showing comparative results on a number of automobiles measured for riding comfort on the Purdue University three-dimensional accelerometer.

Without the intervention of equations, any of the cars may be "placed" immediately with respect to their general comfort characteristics, on the "comfort index" at the left of the chart.

Research Instruments

In the past a number of ingenious instruments have been designed to meet the specific requirements of individual riding comfort researches[5]. Certain of these have enabled the measurement of the fatigue of the passenger thus permitting direct interpretation of the mechanical vibrations of the motor car in terms of their fatigue effect on the passenger.

An optical accelerometer recording simultaneously in three planes[6] enables accurate determination of the accelerations resulting from the car passing over a single, or comparatively short length of road obstruction. A three-dimensional recording instrument[7] has been made commercially available, which should prove of value in measuring the displacement of low amplitude, high frequency vibrations.

As the Purdue University three-directional accelerometer has been illustrated elsewhere[6], only selected results will be shown at this time. Fig. 6 shows the graphical results from the tests of nine cars under exactly similar test conditions. The index, derived from a very simple analysis of the forces and their frequencies in the three directions, has been developed from the human reactions to several hundreds of rides and are purposely set lower than the mean reactions. For these tests, the accelerometer was placed in a dummy (simulating a passenger) in the left rear seat. The left wheels of the cars were then driven over a reference "bump" on a relatively smooth concrete road at the indicated speeds. It is apparent that two cars were particularly comfortable, while the 1929 heavy eight cylinder seven passenger sedan with a special seat and one of the 1934 low-priced sixes gave the most uniform results. Severe resonance of some part of the suspension system was present in the 1934 heavy eight at about 12 and 40 miles per hour.

It is believed the development of the practical instruments described, used in conjunction with the various instruments already available will provide the automotive "ride" engineer with equipment permitting him, at least in large part, to substitute measurement secured under known conditions for the personal opinion he has heretofore been forced to use in evaluating riding comfort. Thus the science of measurement takes another step forward.

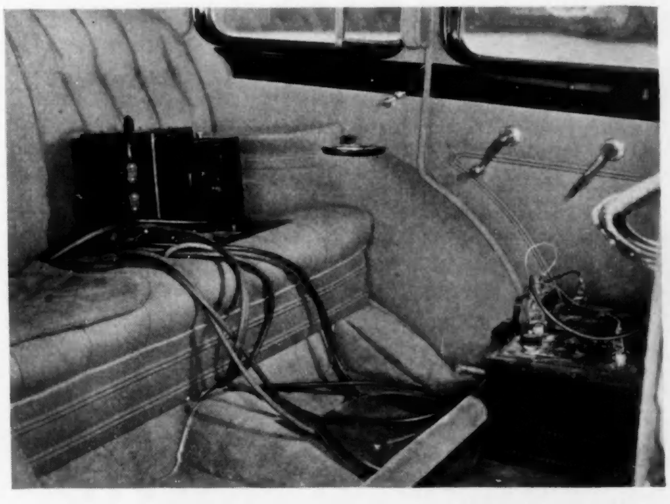


Fig. 7—Riding comfort instrumentation used by M. L. Fox at the General Motors Proving Ground.

Inflatable air cushions are placed between the passenger and the seat cushions in both horizontal and vertical positions. The air pressure from the cushions is transmitted by two small hose to the recorder. Pressure-recording pens produce a graphic record on a continuous strip of transparent paper, permitting direct visible comparison of records secured under similar test conditions but with different equipment.

[5] See S.A.E. Journal, May, 1931, pp. 577-583.
[6] See Research Series No. 44, Engineering Bulletin, Purdue University, Lafayette, Ind.; Riding Comfort Analysis, by H. M. Jacklin and C. J. Liddell. Mr. Jacklin points out that by this method can be procured quickly an index which definitely places a test car in one of three classes so far as its reaction is concerned in passing over a series of reference bumps. The line charts obtained do not involve complicated equations.
[7] J. E. Shrader, Vibration Specialty Co., Philadelphia, Pa.

Papers from Recent Meetings in Digest

HERE are digests of papers presented at recent Section or Regional Meetings of the Society.

* * * *

Some of these papers will be printed in full in the S.A.E. JOURNAL.

Mimeographed copies of *all of them* will be available, until current supplies are exhausted, at a cost of 25 cents per copy to members; and at 50 cents per copy to non-members. Orders for mimeographed copies must be accompanied by remittance and should be addressed to Sessions Secretary, Society of Automotive Engineers, 29 West 39th St., New York.

South Bend Regional Meeting Paper

Wednesday, April 24

Quill Bearings—Past, Present and Future—*H. D. Allee, manager, automotive division, Bantam Ball Bearing Co.*

QUILL roller-bearings, technically termed cageless roller-bearings in which the ratio of roller diameter to roller length is less than 1 to 4, have been used from time immemorial, but modern heat-treatment and precision accuracy in production quantities were needed to initiate them into their present widespread usage.

In general the quill roller-bearing consists of an inner race-member and an outer race-member with the space between filled with rollers that are long with respect to their diameter.

As a result of experiments, it is stated that commercially satisfactory bearings are practical in all sizes up to 4-in. shaft-diameter.

Some of the subjects considered are the difference between the quill-type and the full-complement type, economic reasons for the popularity of quill bearings, statistics regarding the use of quill bearings, and citations of their various applications. In conclusion it is stated that the limitations for the successful application of quill bearings are the limits of the imagination.

No. California Section Paper

Tuesday, March 12

Factors Affecting Gasoline Consumption in Automotive Vehicles—*C. F. Becker, supervisor, motor laboratory, Associated Oil Co.*

THE purpose of this paper is not to offer any specific recommendation or suggestion of how fuel efficiency may be improved in automotive operation, but merely to point out and discuss the factors which increase fuel consumption and possible methods of their detection and correction. The various items mentioned and discussed are based on tests made with automotive equipment during a period of years. The paper is confined to the discussion of gasoline.

All of the items affecting gasoline consumption in automotive equipment must be considered if maximum ton-miles per gallon are to be obtained. These items are listed.

During the last few years the vehicle manufacturer has taken steps to improve the power and fuel efficiency of engines. This has been accomplished by improved combustion-chamber design, higher compression, more efficient cooling of pistons and valves and by improved design of manifold, carburetors, and fuel systems.

Improvements in vehicle performance and fuel economy can be obtained by increasing the compression ratio. Conversion of equipment to a maximum compression suitable to the antiknock value of the fuel appears to be a practical method of improving fuel efficiency. Lack of proper carburetor adjustment can do more than any other factor in causing a waste of gasoline and consequently low mileage. The use of direct continuous types of exhaust-gas analyzers has proved extremely satisfactory as a means of maintaining proper combustion in fleet vehicles.

Losses during summer operation, when fuel systems run too hot, and other items which have a material effect on engine power and fuel economy such as the electrical-system units and ignition timing, are considered.

It is stated in conclusion that the commercial fleet operator, by careful study and periodic inspection and testing of the various items mentioned and discussed, can make an appreciable improvement in the performance and fuel efficiency of his equipment.

Hartford Regional Meeting Paper

Friday, April 26

Critical Stresses in Aircraft Engine Parts—*C. F. Taylor, professor, automotive engineering, Massachusetts Institute of Technology.*

ALTHOUGH it has been customary for machine designers to determine the size of stressed parts by computation based on the applied loads and on the elementary formulas of applied mechanics, and then to use a generous "factor of safety" in doubtful cases, these methods are quite inadequate in the case of high-speed-engine parts. For engine parts which are under fatigue loading and always have regions of stress concentration, the critical stresses are of a local character.

Detailed consideration is given to local stresses, and a brief review of the endurance properties of the more important aircraft-engine materials is given. These materials include steel, aluminum alloys, magnesium alloys, and bronzes. Design procedure and empirical methods of stress determination are cited.

In conclusion it is stated that even when the stress determination has been determined and suitable design changes made to distribute the stresses as evenly as possible, exhaustive testing under service conditions is still necessary.

What Is the Destination for Motor Transportation?

By Austin M. Wolf
Consulting Engineer

UNJUST legislation in the middle of the 19th Century retarded the introduction of road locomotion. The Motor Carrier Act, 1935, calls for extreme regulation, patterned after railroad control.

The many differences between the two services prevent like treatment without strangling the virtues and economies of motor transportation. The difficulty of attempting to regulate it is due to the fact that most "fleets" consist of one truck which is owner-operated and only 9 per cent of all trucks are of the For-Hire type.

The present predicament of the railroads is due chiefly to general conditions brought about by the depression, the result of over-regulation, and in not keeping in step with the advancement of other industries. The passenger automobile accounts for some loss of revenue, but its use is taken for granted. It therefore seems strange that the other forms of rubber-tired vehicle are not accepted in the march of progress.

The Motor Carrier Act has passed the Senate with slight changes and now awaits action by the House. Most State Legislatures continue to introduce measures which would unduly restrict motor transportation. The N.R.A. Trucking Code had a very salutary effect on the industry and made possible the gathering of statistics which had heretofore been unobtainable.

The railroads and their affiliated companies utilize motor transportation to the extent of approximately 48,000 trucks, tractors and trailers.

Uniform codes are desirable in the interest of convenience and safety, and are making headway under the sponsorship of national, impartial organizations.

IN this day of regulation and regimentation, it is hazardous to make a prediction about almost anything. There is not even a differential equation that could cope with the unknown factors of present-day conditions. Since we are all, to some extent, groping in the dark, a discussion of today's issues might stimulate some insight into the possibilities of the future.

The lot of road locomotion has been apparently a very unhappy one, not alone for those in the industry, but for the world at large. Following Cugnot's gun tractor of 1769 and Murdock's crank-operated machine of 1784, there was considerable activity in the early 1800s on steam road-coaches and steam rail-locomotives, particularly in England. These coaches showed remarkable ingenuity as exemplified in Gurney's, Hancocks, Church's, James' and other vehicles. When speeds of 20 m.p.h. had been reached and regular service was about to be established around 1840, citizens and railroads objected to such use of the highways by these "juggernauts," and laws were passed subjecting all horseless vehicles to heavy tolls for the use of the roads of that day. Speed was limited to 4 m.p.h. and it was required that a man precede the vehicle on foot, carrying a red flag by day and a red lantern by night. This sounded the death knell to a promising industry and these laws were not repealed until 1896. These early steam vehicles were exceedingly heavy, but it seems certain that, had natural progress not been thwarted, the pages of history might have recorded quite a different picture. The half century that passed during which vehicle and road construction stood still has robbed the world of a priceless heritage and the true automotive age was sadly retarded. It remained for Daimler, Benz, Haynes, Duryea, Ford and others to resurrect the art of road locomotion through the use of the internal-combustion engine. Today, with changed conditions and aspirations, most citizens have a different viewpoint, but the railroads naturally would still desire the man with the red flag and lantern.

Federal Coordination of Motor and Other Transportation.— The report of the Federal Coordinator of Transportation on Transportation Legislation, dated Jan. 21, 1935, House Document No. 89, states:

"The main reason for the present low earnings of the railroads is loss of traffic. They have nothing to sell except service to others and if products are not produced or people do not travel, railroad traffic falls off accordingly. They reflect

[This paper was presented at the Semi-Annual Meeting of the Society of Automotive Engineers at White Sulphur Springs, West Va., June 17, 1935. Headquarters of the Society are at 29 West 39th St., New York City.]

general economic conditions very closely. But this is not the only reason for loss of traffic. In recent years there has been an extraordinary growth of competitive forms of transportation. Most remarkable has been the development in a comparatively short span of years of thousands of miles of hard-surface highways teeming with millions of automotive vehicles. Traffic domains, which for years the railroads regarded as exclusively their own, are now everywhere penetrated with competition from the highway vehicle. This is true of both passenger and freight traffic. There has also been a rebirth of inland-waterway competition, coastal and intercoastal water competition has grown more intense, pipe lines have invaded the gasoline as well as the crude-oil traffic, the great coal traffic has been curtailed by the incursions of fuel oil, natural gas and hydroelectric power, the airplane has taken its place in the transportation scene, and there has been a tendency for industry to decentralize and spread for the very purpose of avoiding transportation costs."

In view of the foregoing, the Coordinator seeks Federal regulation of all transportation agencies. Under his recommendations, the present Interstate Commerce Act which will constitute Part I would be supplemented by the proposed "Water Carrier Act, 1935" as Part II, and the "Motor Carrier Act, 1935" would constitute Part III. The latter bill was introduced concurrently on Feb. 4, 1934, to Congress (Hr.-5262, introduced by Mr. Huddleston and S.1629, introduced by Senator Wheeler) "to amend the Interstate Commerce Act, by providing for the regulation of the transportation of passengers and property by motor carriers operating in interstate and foreign commerce, and for other purposes." It proposes the regulation of all common and contract motor carriers of passengers and property and the licensing of transportation brokers, in interstate and foreign commerce, and the regulation is vested in the Interstate Commerce Commission.

Automotive engineers are familiar with the various sections of the Bill. It will be of interest to examine some of the opposition met with at the Congressional Committee hearings, indicating that tight-laced railroad-type regulation is neither necessary nor desirable. (See Appendix 1.) The National Grange found no need for regulation, since truck rates were reasonable, the service thoroughly adequate, but they feared higher rates with regulation. It was felt that the need that existed for railroad regulation has no counterpart in the automotive-transportation field. The farmer recognized very quickly the advantages of motor transportation[1]:

"Transportation of live stock by motor truck from the near-by points is steadily becoming a larger feature of the receipts of some of the principal markets. This method of transportation is becoming increasingly popular with the producers. The limiting factor seems to be the amount of space available at the yards for unloading purposes. At many of the stockyards, few or no facilities are provided so that the stock are often injured when unloaded. If proper unloading chutes can be furnished at all the markets, motor-truck transportation can and will continue to spread. The cost of transportation by motor truck is considerably higher than by freight train. At St. Joseph, Mo., the usual rate from points 30 to 50 miles away is 50 cents per 100 lb., with a slight increase from points more distant. From near-by points the rate is usually so much per load, without a definite permanent basis. The advantage to the farmer, which offsets the high rate, is the speed with which the stock can be handled from the farm to the stockyard and the possibility of shipping in smaller quantities than by rail."

The small-scale operator undoubtedly will be the chief sufferer, as indicated by the Coordinator in his report to Congress, Senate Document No. 152, Feb. 28, 1934, which stated:

"It is likely that regulation of the kind proposed will somewhat lessen the flexibility of truck operations and set up requirements which small but poorly financed operators will not be able to meet."

Flexibility is the very virtue of motor transportation. Again House Document No. 89 says:

"While truck manufacturers have done extraordinary work in developing the truck and of late have done much to educate operators in its more efficient use and operation, some have at least not discouraged harmful practices of their sales representatives. Inexperienced, and often ignorant and poor, individuals have been induced to buy trucks on the installment plan by high-pressure salesmanship and reckless representations as to prospects for traffic and earnings. Such exploitation of operators has been a substantial factor in the present low state of the industry. While it is understood that this condition has been much improved, there is need for a thorough house cleaning of sales practices."

The motor industry does not approve of selling to irresponsible buyers, but the interception of small sales is too far-reaching when it is considered that the Government would have the right to interfere with the ultimate placement of a new $600 truck. Such competition is certainly not responsible for the present condition of the railroads. The cost of any truck is not to be compared with that of rolling stock or ships. Regulation of this type is restricting initiative to the favored few. The farmer, transporting an occasional load for a neighbor, would have to defend his action on complaint of a railroad or other carrier. The small operator cannot be compared with the railroads, even with small branch-lines, nor could he cope with their legal set-up. The granting of permits within the discretionary power of the Commission and its determining whether or not an operation will be consistent with the public interest, conveys unlimited power of restriction.

There is considerable opinion that Federal law should not attempt to force all types of transportation to assume a common level. Representatives of dairy products and fruit growers indicated the cheaper, more efficient and more flexible type of transportation furnished by the truck. The bus-operators group seriously questions the advisability of giving the Commission complete rate-making power over motor vehicles.

The Bill covering General Duties and Powers of the Commission; Administration; Application For; Issuance; Terms and Conditions of Certificate of Public Convenience and Necessity; Permits for Contract Carriers; Dual Operation; Brokerage License; Suspension, Change, Revocation and Transfer of Certificates and Permits; Consolidation, Merger and Acquisition of Control; Issuance of Securities; Security for the Protection of the Public; Rates, Tariffs and Schedules; Accounts, Records and Reports; Orders, Notices and Service of Process; Unlawful Operation; Collection of Rates and Charges, etc., constitute the same intricate railroad die with just a modified trimming die so that the edges of the stamping will show a road instead of railroad tracks. The provisions on "Consolidation, Merger and Acquisition of Control; Issuance of Securities and Security for the Protection of the Public" have not been thought about by the motor-transportation industry which has been too busy over its growing pains.

[1] See Report of the First Commission of Agricultural Inquiry on Transportation, Part 3, Document H-408, 1922.

Table 1—Ownership of Motor Trucks

Trucks Registrations[a]		3,226,747
Trucks on Farms[b]	900,385	
Publicly Owned Trucks[c]	31,346	
For-Hire Trucks[d]	300,475	
Privately Operated Industrial and Commercial Trucks[e]	1,994,541	3,226,747

[a] U. S. Bureau of Public Road Figures of 1933 Registration, all States.
[b] U. S. Census of Agriculture, 1930.
[c] Survey of Ownership of Fleets, May, 1934, by National Automobile Chamber of Commerce.
[d] Registration under N.R.A. Code for the Trucking Industry for Code Period Feb. 10, 1934, to Feb. 10, 1935.
[e] Balance of Registered Trucks.

History could hardly repeat itself with motor transportation in view of the wide differences, fundamental and detail, between the two.

The provisions of the Bill would tend to drive shippers to operate their own fleets of trucks as private carriers but toward the end, in Sec. 325, the "private carriers of property" would eventually come under regulation as to sizes and weights of the vehicles and combination of vehicles. Should this transpire, every State would hurriedly follow suit to regulate the private truck. Since the Bill is set forth as a protection to the common carrier, the private and contract operators would be indirectly in line for regulation.

There are numerous provisions in the Bill that are not compatible with the industry as we know it. Federal regulation would warp it entirely and stifle it to the advantage of the railroads and to the disadvantage of the public. We want to serve the public, but all these proposals permit it only in terms of railroad consideration. The problem of motor transportation should be solved along the lines of what is best for the public and not what is best for the particular transportation group.

The opening paragraph on Regulation and Taxation of Highway Transportation[2] states:

"The public is entitled to the benefit of the most economical and efficient means of transportation by any instrumentalities of transportation which may be suited to such purpose, and no legislation should be enacted which has for its purpose the stifling of any legitimate form of transportation. The supreme test must always be the interest of the public. The public's right to the selection of the agency of transportation which it wants and which it finds most useful must be respected. . . . Section 500 of the Transportation Act should not be construed as an expression by Congress of preference for rail or water transportation over transportation by motor vehicle, nor as a declaration by Congress of the relative importance to the public of the several kinds of transportation."

Quoting from the Report of the National Transportation (Coolidge) Committee, Feb. 13, 1933:

"One thing is certain. Automotive transportation is an advance in the march of progress. It is here to stay. We cannot invent restrictions for the benefit of railroads. We can only apply such regulation and assess such taxes as would be necessary if there were no railroads and let the effect be what it may."

The day has not yet arrived for the motor-transportation industry to be put under the proposed regulation. Consider the railroads, about 100 years old with 48 years of regulation by the I.C.C., as against trucks about 25 years old and with 1 year under the Code.

[2] See Recommendations of the Joint Committee of Railroad and Highway Users, Jan. 30, 1933.

The present urgent desire for Federal regulation seems a surprise when considering the attitude of the I.C.C. in 1932 where, in its annual report in reference to the regulation of trucking rates, Docket 23,400, it stated:

"There is substantially no demand for public regulation of the charges of motor trucks to protect shippers against exorbitant or discriminatory charges. The demand has been chiefly from the railroads, and for the prescription of minimum rather than maximum charges."

"Indications are that the number of motor-truck operators is very large and that their operations are mostly on a small scale. Regulation which is appropriate and practicable in the case of a comparatively few large well-organized companies may be quite impracticable in the case of a multitude of individuals or small concerns."

"A further consideration is that the Federal Government is wholly inexperienced in this field of regulation. Under these circumstances we deem it wise to make haste slowly," and, as noted in the 1932 Annual Report, page 20, "to be guided by the experiments which the States are making in this direction, and by its (the Commission's) own experience in regulating the charges, practices and service of motorbuses, if the latter regulation be established as we recommend."

Due to its fixed rates and schedules, the bus lends itself to regulation; but the truck is the reverse and to regulate it would rob it of its usefulness. Preliminary experimentation with bus transportation would still leave much to be uncovered in the truck field with the different types of carrier, variations in equipment, services, loads, routes, and the like.

The general distribution of trucks is shown in Fig. 1 and is based on the data supplied in Table 1, compiled by American Trucking Associations, Inc. It will be noted that the "For-Hire" industry represents 9.31 per cent of the entire number of trucks in operation. A true cross-section of the "For-Hire" trucking-industry is shown in Fig. 2, which gives fleet sizes as analyzed by the registration under the Code

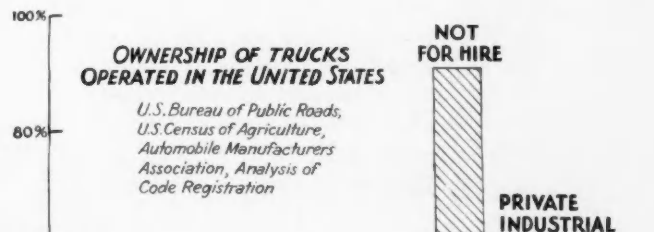


Fig. 1—General Distribution of Trucks

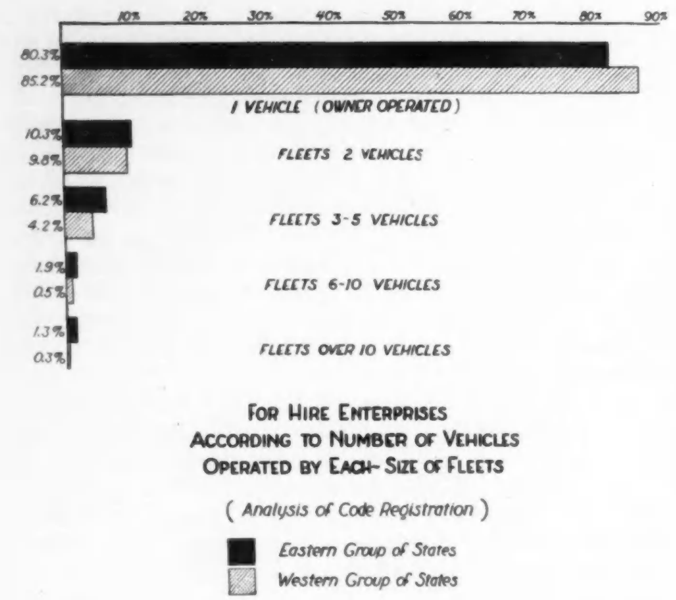


Fig. 2—Fleet Sizes as Analyzed by the Registration under the Code of Fair Competition for the Trucking Industry for Its First Year

of Fair Competition for the Trucking Industry for its first year. It will be seen that fleets of over 10 vehicles represent only 1.3 per cent and 0.3 per cent of the eastern and western groups of States, respectively, and 1.9 per cent and 0.5 per cent for fleets of 6 to 10 vehicles. These proportions should be given proper consideration when examining Exhibits 117A, 117B, 117C, 117E, 117F and 117R of the Merchandise Traffic Report, 1934[3], which is based on the replies from truck operators of 10 or more vehicles engaged in intercity operations as common carriers, truck haulers or private operators. The number of employes in the "For-Hire" industry, taken from Code registrations, is shown in Fig. 3 in which owner-operated or one employe amounts to 82.2 per cent; two to three employees, 12.6 per cent. Large operators represent a surprisingly small percentage. Based on Code registrations, the percentage of "For-Hire" vehicles crossing State lines is shown in Fig. 4, based on the information given in Table 2, representing 19.68 per cent of all vehicles operated in interstate service.

Control, to be effective, must cover the little fellow. He certainly predominates. The railroad is to all intent a monopoly operating over a fixed, private right-of-way and is underwritten by a large investment. Motor transportation is essentially individualistic, is flexible, bears no similarity to the railroads, in most cases represents a small outlay of capital, and keen competition is a check on its rates. The truck or bus will go anywhere, being extremely mobile, flexible, responsive and alert. It is the "nature of the beast." It will be seen that this very virtue is held against it.

The truck will do things that no railroad service can accomplish in reaching inaccessible places, preventing duplicate hauling and carting, and permits the swift replenishment of stocks which are carried on a day-to-day basis. The public appreciates advancement and demands it. The truck is essentially for the transportation of small units and is therefore more flexible than car or train loads. The L.C.L. situation has long been admitted by the railroads to be a losing field for them.

It is well known that requests for regulation come from neither the motor industry nor the shipper. The railroads desire it and a few large-scale truck-operators. The State Commissioners are also for it, due to the greater importance they would assume locally in the general scheme. However, jealous of encroachment in their field whereby the "Shreveport clause" might give the I.C.C. jurisdiction over intrastate rates, when and if such rates were found to be prejudicial or discriminatory to interstate commerce, the Commissioners have voted against this portion of the bill.

The railroads have been, are and will continue to be, the chief element in transportation. There is no fear of their fading out of the picture, because they are bound to advance. Their day of standing still is over. Railroad-equipment design has been stagnant as compared with other industries. The realization of the need for keeping abreast with other industries has long been appreciated. In 1922, the Report of the Joint Commission of Agricultural Inquiry on Transportation, Part III stated:

"The transportation systems must be continually improved to keep pace with industrial progress. It is possible to cheapen transportation through intensive development such as electrification, improvement of rolling stock and other equipment and the use of most modern methods in the loading of trains. This country has enjoyed railroad transportation on a cheaper basis than practically any other civilized country in the world, but cannot continue to do so by restricting initiative or by undue limitation of railroad profits earned under uniform and reasonable rates."

The loss of revenue to the railroads is not as great as reports would indicate. The percentage of freight moved by intercity trucks in 1932 is given by the I.C.C. as 9.4 per cent, and 4.2 per cent in 1929. An apparent mistake was made in the former calculations, as pointed out by John S. Worley[4], who indicates that there was approximately 1.1 per cent loss

Table 2—Vehicles Operated Interstate Registered Under the N.R.A. Code for the Trucking Industry[a]

Region	Total Vehicles Registered as Reported Feb. 15, 1935	Vehicles Operated Interstate	
		Percentage of All Vehicles	Number
New England	34,021	16.06	5,464
Middle Atlantic	66,740	24.81	16,558
East North Central	23,874	27.02	6,451
West North Central	77,187	19.01	14,673
South Atlantic	8,200	20.19	1,655
East South Central	38,972	24.02	9,361
West South Central	12,387	15.01	1,858
Mountain	11,611	12.66	1,470
Pacific	27,483	6.01	1,652
Total	300,475	19.68	59,142

[a] Analysis of 165,842 registrations, totaling 267,532 vehicles, was used as a basis for projecting the above tabulation.

[3] Prepared by the Sections of Transportation Service, Federal Coordinator of Transportation.

[4] See "Imminent Destruction of Our Railways Due to Competition by Other Unregulated Transportation Agencies", by John S. Worley, professor of transportation, University of Michigan.

in railroad revenue for 1932 compared with 1929. He also shows that motor transportation applies only to 0.24 of 1 per cent of the freight moved in the United States insofar as common carriers engaged in interstate commerce are concerned. Interstate transportation of all For-Hire trucks amounts to 0.59 of 1 per cent.

Since the truck and bus are accountable for a small percentage of the total transportation of the country, to what can some of the loss of railroad revenue be attributed? Fig. 5 shows all travel-miles to 1934 inclusive and is taken from Hale's chart. It is readily seen that the passenger traffic in private cars has changed the entire complexion of the previous transportation picture. People are travel-conscious as never before in the history of the world. If the private cars are taking revenue away from the railroads, according to the philosophy of Federal regulation, they also should be controlled, since a goodly portion of them is used in interstate travel. This could not be done in view of its wide use by "rich man, poor man, beggar man and thief." It is universally accepted as a tool in the march of progress. Our country is now inhabited so that the distribution is quite different from that of the pre-automobile era. Communities and factories have been built up along main roads. Suburban communities have been made possible only through the use of the automobile. In 1905, people resided in belts extending approximately 10 miles on each side of some main line of railroad.

Passenger cars, trucks, and buses belong all in one family. The rubber-tired self-propelled vehicles run anywhere over any roads and differ from the flanged-wheel units running restrictively over rail roads. It is unfair to attempt to separate out one or two species and conveniently overlook the other. For the same reason that the passenger car is accepted today as a necessity and a new tool of civilization, so should the truck and bus be accepted in like manner.

The present plight of the railroads can be attributed to the reaction of tight-laced over-regulation as it concerns all phases of operation and engineering, with the strangulation of healthy expectant growth and losses due to the years of depression as with all other industries. It is very unfortunate to be compelled to make analogies between the two forms of transportation when conditions are so far from normal. Strained financial conditions in the railroad field date far back to the period before there was any competitive transportation. Starting in 1876, bankruptcies became conspicuous and operation by receivers is all too well known.

History repeats itself, and we find the same characters and incidents differently clothed and in different surroundings.

"In 1850, the alarming discovery was made that the railroads, which had been intended for passenger traffic only, were becoming formidable competitors of the Erie Canal[5]. The whole Commonwealth was agitated, and there was strong sentiment in favor of legislation to prohibit any such competition; and, as late as 1858, people were still holding meetings and resolving that the railroads had no right to compete with the canal. But the march of progress could not be delayed. The canals had to cut rates to meet the competition of the railroads and tolls were levied on railroad freight the same as on canals. Some of the roads in the chain from Albany to Buffalo were limited by their charters to the carrying of passengers, and they had a hard time getting permission to include the transportation of freight in their business."

[5] See Report of the Joint Commission of Agricultural Inquiry on Transportation, Part 3, H-408, 1922.

The George Washington Bridge between New York and New Jersey caused divergence of traffic from the Dyckman Street ferry, which ceased operations in December, 1934. No attempt has been made to sustain the ferry company. Radio users are not required to pay a tax to the motion-picture industry. Neither does the oil-burner industry pay anything to the coal industry, nor the rayon industry to the cotton industry. Increased taxation or cost due to unnecessary regulation instigated by another group should not be assessed against motor transportation.

There seems to be a mistaken opinion in the public mind, fostered by adverse propaganda, that there is no present regulation of motor transportation, but that it is running free of any restrictions whatsoever. This is not the case, since practically every State has regulations covering the common carrier, the contract carrier and the bus lines.

It is not regulation that motor transportation is objecting to, because it has been regulated since its inception; but it objects to the type of regulation that threatens its very existence and inherent advantages. Federal regulation is not objected to if it is made the basis of study for future measures when their desirability has been proved to all concerned, including the public, to include safety measures, uniformity of laws and requirements of financial responsibility and insurance.

These facts have already been established. The Joint Committee of Railroads and Highway Users went on record to the effect that:

"In principle, all those using the highways for commercial purposes in interstate and intrastate commerce should be subjected to regulation. . . . Common carriers of persons and/or property in interstate commerce on highways should be under the jurisdiction of the Interstate Commerce Commission, or other properly constituted Federal tribunal, and should be required to obtain certificates of public convenience and necessity."

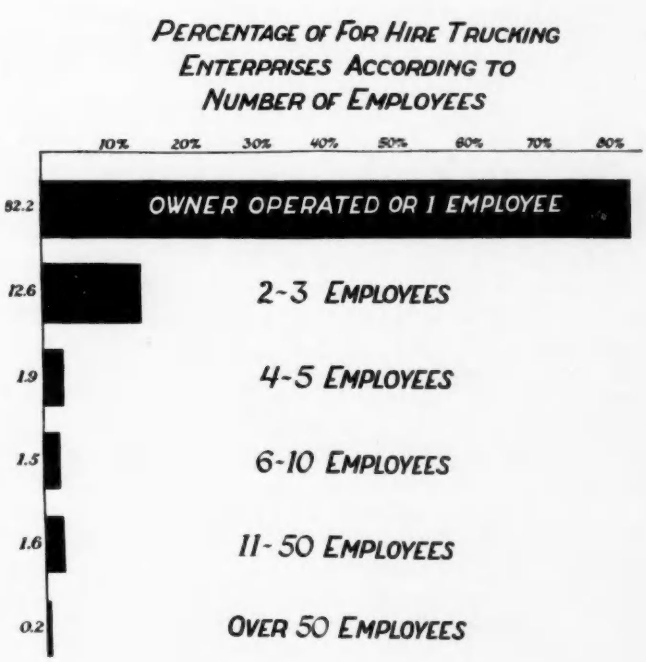


Fig. 3—Number of Employes in the For-Hire Industry

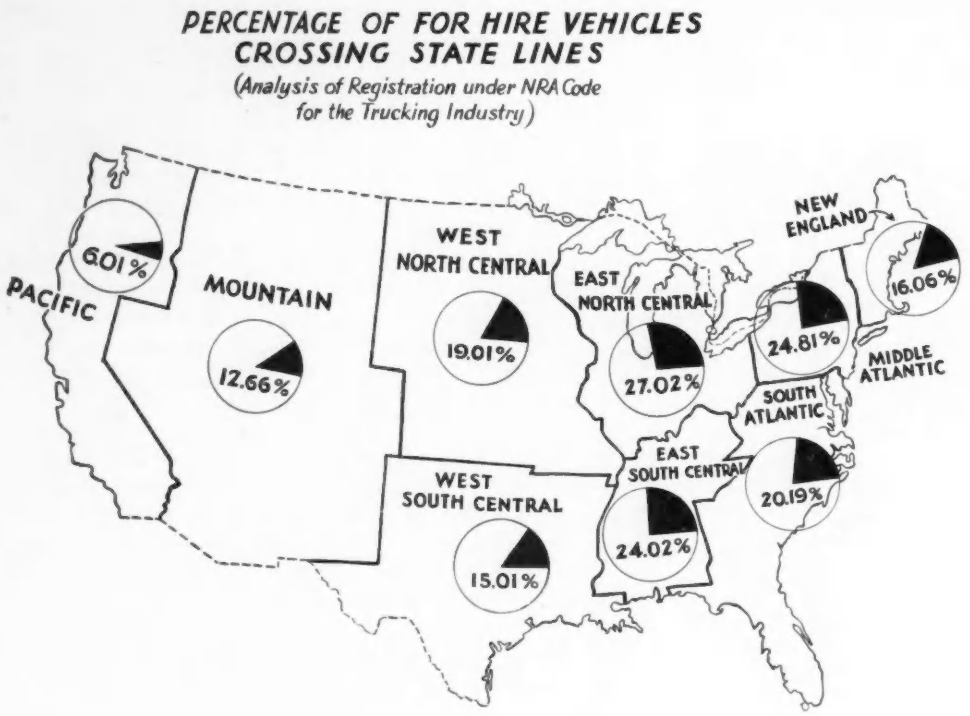


Fig. 4—Percentage of For-Hire Vehicles Crossing State Lines

While the railroads wished all common carriers in interstate and intrastate commerce to insure just and reasonable rates, and the contract carrier to observe minimum rates fixed by regulatory authority, the Highway Users agreed to these provisions "if and when sufficient data have been collected to indicate the desirability of such regulation in public interest." The crux of the situation today, with the Motor Carrier Bill now pending, is that the automotive-transportation group does not believe that sufficient data are available on which a suitable coordination of all transportation facilities can be evolved along the lines proposed.

"What is needed most of all, in consideration of the problem of regulating motor vehicles[6], is more factual data. Not opinions, but facts, should govern the course of future legislation. Broad and truly impartial investigations of the whole problem must be made from diverse points of view. From engineers must come facts as to the cost of construction and maintenance of the various types of highways designed to meet various traffic needs, and the effect upon the roads of the physical characteristics of vehicles; from economists, facts as to the true place of motor transport in the general transportation structure and the fair charges to be borne by the various types of vehicle in compensation for the road facilities provided for them; from safety experts, further advice on the uniform control of traffic and the reduction of accidents; from officials of government, facts on standardized regulation, adequate protection for the public, reciprocal privileges among the states, and effective enforcement."

Should the compilation of data started by the Trucking Code be impossible of further continuance in view of the demise of the N.R.A., it would be desirable for the I.C.C. to continue it for factual information but under the guidance of a separate and adequate division for the administration of the automotive activity. There has been full realization of the need for, and considerable discussion of, the reorganization of the I.C.C. for this division and the support of the Motor Carrier Bill by the American Trucking Associations has been predicated on this basis.

Congress and Motor Transportation

The third clause of Section 8 of Article I of the Constitution provides that Congress shall have the power "to regulate commerce with foreign nations and among the several States and with the Indian tribes." When the Constitution Commission met on this provision, it was agreed upon without a dissenting vote. It grew out of the difficulties arising from the failure of the States to agree upon a uniform regulation of commerce under the Articles of Federation. This sounds rather modern!

The recent fireside chat by the President indicates his desire for Federal regulation of all transportation means. The Bill has passed the Senate with only minor changes. (See Appendix 2.) The Senate's action was perfunctory and the real test of regulation will be in the House, where it now rests for consideration. It is fortunate that Mr. Huddleston is a member of the House Committee, in view of his true appreciation of the real status of motor transportation. At the Proceedings he remarked: "The reason we have had no legislation before is because its proponents always wanted to go to extremes. Here is a Bill recognized as the last word in regulation, yet it goes further than any railroad regulation law proposed."

The American Trucking Associations, based on a policy adopted at their first annual convention in Chicago, October, 1934, decided to "cooperate with the Coordinator of Trans-

[6] See *Public Roads*, December, 1932; "The Problem of Motor-Vehicle Regulation", by H. H. Kelly.

portation and the Administration in the development of a sound national transportation-policy, retaining at the same time the economy and flexibility of motor transportation."

The Association is committed to reasonable regulation of the For-Hire trucking industry. Their policy committee has made recommendations to Mr. Eastman which they expect will be incorporated in the final passage of the bill.

State Legislatures and Motor Transportation.—With the presentation of 5000 bills in this Spring's crop of State-Legislature endeavors, there is no question but that this phase of motor legislation requires careful watching. There is great need for engineering judgment coupled with legal endeavor, particularly at this time, to check impractical legislation. The recent ruling by the Motor Vehicle Department of the State of Rhode Island, requiring of commercial vehicles a speed of 20 m.p.h. on a 4 per cent grade, is indicative of what might be enacted into legislation without sufficient engineering consideration.

Kansas inaugurated the "Port-of-Entry" law, which was originally designed to check the contents of all liquid-fuel-importing trucks. It now covers all trucks and buses for the collection of taxes and mechanical inspection. The tax collected amounts to 1½ cents per mile for a gross load up to 15,000 lb.; 2 cents per mile for 15,000 to 25,000 lb.; and 3 cents per mile over 25,000 lb. A new law requires all vehicles carrying intoxicating liquors to report at an established port-of-entry and have the cargo duly inspected and sealed. There is a $2.50 charge for such inspection in addition to all other fees and charges. New Mexico has just created a "Port-of-Entry" Board along the lines of the Kansas example, with fees of ¾ cent to 3 cents per mile, depending on the gross weight and with provisions for inspection. Maine has set up six Ports for checking the weight on the registration card. Nebraska will stop only vehicles transporting petroleum products. Such legislation is unnecessary if the laws are properly enforced by the States' own Highway Patrols. Conditions simulating Colonial days are recurring, and we might as well have forty-nine countries instead of a United States. Imagine a Port of Entry at the Holland Tunnel! Still bills are being presented in many States for such Ports.

The Pennsylvania Public Service Commission has strangulated intrastate transportation by making it practically impossible to secure permits. To prove the evidence of necessity for such service is practically impossible. As a result, home industries are rotting or being driven out of the State. The condition is unbelievable in this Twentieth Century, savoring rather of the Dark Ages[7]. All trucking is done by interstate trucks, bringing in goods manufactured in other States. This is an example of regulation for industrial suicide. In distinction to this, the Wisconsin Public Service Commission has held that transportation services and operations performed by the railroads and various motor carriers are so dissimilar that an identical rate-basis would do justice neither to the carriers nor to the shipper.

Further legislation on compulsory inspection, the use of safety glass, portable flares and clearance lights has made further headway. Regulation of private trucks has been enacted by Wyoming, coming under the Highway Commission, empowering it to refuse to issue permits "if the proposed operation or the equipment to be used shall render the highway unsafe for the public." Idaho and Indiana are trying to copy Wyoming, but with more severe provisions. In a Bill introduced in the Indiana House, the Public Service Commission would be given the power "to designate from time to

[7] See *Commercial Car Journal*, March and May, 1935, p. 50 and p. 33; "True Stories of the Evil Effects of Regulation".

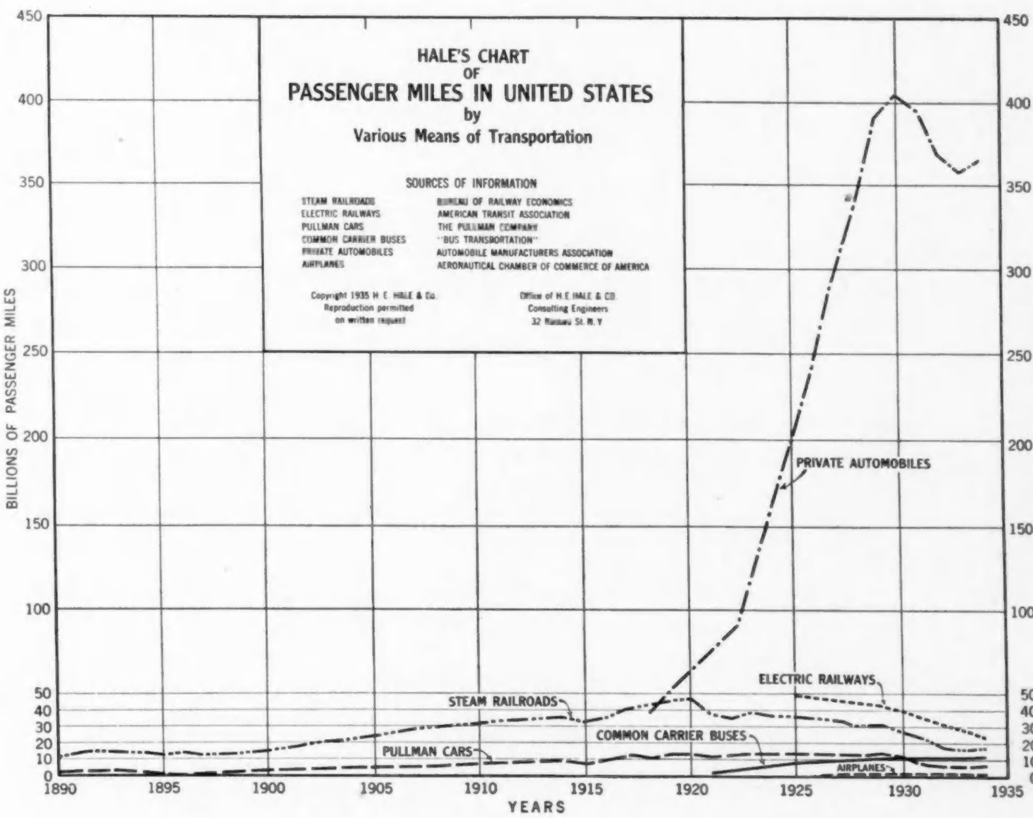


Fig. 5—Travel-Miles from 1890 to 1934 Inclusive

time the public highways, as routes, over which carriers subject to the provisions of this Act may or may not operate, and to designate the time that such vehicles shall or shall not be operated thereon, so as to prevent congestion." A Georgia House Bill would prohibit trucks and trailers in excess of ½-ton capacity from using the highways on Sunday. An Ohio House Bill does likewise with vehicles weighing in excess of 5 tons. While these are only Bills, they reflect current thought.

Bills have been introduced in a number of States which would prohibit the operator from driving more than 8 hr. in a 24-hr. period, or 10 hr. spread over a total of 12 consecutive hours. On the subject of labor, the "fuel crew" is attempting to create a counterpart in automotive transportation. A California Bill would prohibit the operation of buses in excess of 21-passenger capacity in a city area unless it has a crew of two men. Massachusetts and Nevada would require a crew of two drivers for a vehicle of over 3-ton capacity traveling a distance of 50 miles. North Dakota would require a crew of a driver and an assistant for buses with a capacity of more than 10 passengers running regularly between cities.

In the desire to prevent foreign trucks from escaping gasoline taxation by the fuel supply, Missouri would prohibit a vehicle from carrying more than one fuel tank of 30 gal. for use in that vehicle in the State. Montana would prohibit auxiliary gasoline tanks. A Bill was introduced in the Nevada House which would levy a 6-cents per gal. tax on Diesel and similar oils. It does not seem that Diesel fuel will remain very long untaxed. A number of States have introduced Bills compelling an alcohol blend, utilizing alcohol produced in the particular State.

The proposed tail-light on Georgia mules, which creates considerable mirth, is nevertheless in keeping with present-day safety-efforts on the road. A number of Bills call for illumination of front and rear license plates. A New York Bill for a translucent plate illuminated by night did not get very far, particularly when it was realized that the Bill covered a proprietary article. Probably one of the best mirth-provoking Bills introduced in the Spring of 1935 is the one introduced in the Oregon Senate which would require all vehicles, after Jan. 1, 1937, to be equipped with a combination license carrier, bumper, and release which will drop the license plate if the vehicle strikes any object. It would also require the license carrier to be equipped with a white light which would automatically be lighted at a speed of 20 m.p.h. or less, a green light to indicate the speed between 20 and 50 m.p.h. and a red light if the vehicle exceeded 50 m.p.h.

The chain store is a target for increased taxation, and a number of proposals would include gasoline filling-stations in the classification of chain stores. The licensing of mechanics is being attempted, and the "caravan" is now being singled as a potential source of revenue. More States are endeavoring to incorporate a mileage tax.

The N.R.A. and Commercial Transportation.—Although the N.R.A. Codes have been voided, it cannot be denied that certain ideals that were behind them are to be commended. Unfortunately, some Codes fostered restriction and monopoly. This, however, was not the case with the Code of the Trucking Industry, which was free from any attempt to curb individual initiative. Unlike the Motor Carrier Act, which would eliminate the little fellow and which was strongly objected to by the agricultural interests, the Code permitted him to operate. The Code has given very valuable aid and information to the industry, and represents the first real attempt in obtaining authentic data to appraise its extent and doings. It made the members more cost-conscious. They learned that benefits could be derived through organization and knowledge of activities beyond their own problems. From the cost-formula data and questionnaires, information was obtainable on the types of carriers, size of fleets, routes, terminals, distances traveled and whether local, intrastate or interstate, commodities transported, employment, capital investment, operating costs, depreciation, taxes, insurance and safety problems. The collected and compiled information is surprisingly complete, and represents the finest work of its kind to date. At the end of its first year of operation, the returns had been obtained on the 267,532 vehicles of 165,842 For-Hire operators.

The Code would have accomplished a great deal had it been continued, since it was just beginning to feel the benefit of Federal and State cooperation in its enforcement. Around the country, motor-vehicle registrars, State police and highway patrols were cooperating in checking registration. Naturally, those States requiring certificates of convenience and necessity were able to check registrations when applications were filed.

The salutary effect of the Code to increase employment and to tone up the industry to a state heretofore unknown, will be denied by no one. The bulk of the industry complied with the Code and the few that were violating the Code on registration, hours of labor, wages and rate provisions, were gradually being weeded out and eventually would have come under control. The cancellation of contracts on T.E.R.A. jobs on order of the Government Contract Division of the N.R.A. was being given impetus. It is interesting to note that some of these violators were supplying 1½-ton dump-trucks with drivers for as low as 75 cents per hr., although many had filed rates of $1.50. Operators in Colorado, Missouri, New York, Nebraska, Michigan and Oklahoma, were taken to court for various violations. Shining examples of convictions would have had a very salutary effect. The delay in hearings hampered matters; but, like all new machinery, corrective efforts evolve slowly.

The Code recognized the widespread activities of the in-

Table 3—Progress in the Use of Trucks in Freight Service by Class-I Railways[a] for Ten Years; 1925 to 1934

Year	Terminal Transfer Service	Intercity Service	Store-Door Delivery Service	Total No. in Service
1925	800	100	0	900
1926	1,450	150	0	1,600
1927	2,900	400	0	3,300
1928	4,350	550	0	4,900
1929	4,500	750	650	5,900
1930	4,750	850	1,400	7,000
1931	5,000	950	4,050	10,000
1932	5,500	1,000	5,500	12,000
1933	6,750	1,150	15,100	23,000
1934	7,175	1,275	16,857	25,307[b]

[a] From Simmons-Boardman Publishing Co.'s "Survey of the Railroad Market for Motor Trucks, and Highway Tractors and Trailers."
[b] In addition to the 25,307 trucks now used in freight service by Class-I Railways, there are other trucks indirectly owned by these lines but not employed in freight service. These trucks are owned by joint subsidiaries of the railways, such as the Railway Express Agency, or by trucking subsidiaries of individual roads, such as the U. S. Trucking Corp., New York, and the Willett Co., Chicago. The number of trucks owned by such companies, and indirectly by the railways, is estimated at approximately 23,000.

Table 4—Railroad Carloads and Revenue from Shipment, 1929 to 1933

	U. S. Automobiles, Parts and Tires		Total Automotive Freight	
Year	Carloads	Revenue	Carloads	Revenue
1929	1,014,392	$204,528,723	3,667,792	$563,411,000
1930	618,487	120,244,443	3,330,000	478,466,000
1931	410,845	76,672,315	3,106,645	396,738,000
1932	214,033	41,251,569	2,543,833	325,000,000
1933	295,999	54,664,463	2,640,910	324,320,000

dustry, and the National Code Authority, on the basis of geographical representation, was an outstanding feature. The varied conditions and widespread activities of trucking were in turn under the control of the State and Divisional Code Authorities. Whether the work can be carried on in the form of a trade organization to perpetuate fair practice remains to be seen.

The Railroad's Use of Motor Transportation.—The railroads have always thought of transportation in terms of railroading. They were unable to visualize the possibilities of motor transportation until in recent years, after the truck and the bus had proved themselves to the most skeptical. Today the railroads are large users of trucks and are interested in a considerable number of bus lines. Their recent experiments in store-door collection and delivery service has washed away all skepticism. Everything points to their eagerness in sooner or later deriving the full benefits of motor transportation.

It is estimated[8] that in 1932 the average load of freight (L.C.L.) moved in intra-terminal merchandise cars was from 3.5 tons to 5.4 tons, depending on the type of operation, which is well within truck or trailer capacities. Box-car freight between nearby cities and towns in 1932 amounted to 5559 regular schedules of merchandise cars over points 50 miles or less apart. The average load per car was 2.7 tons, making the distribution cost approximately 12.5 cents per ton mile on the basis of 34 cents per loaded-car mile. A 75 per cent reduction is possible by substituting the truck with an estimated cost of 3.3 cents per ton mile over similar distances. Store-door delivery-service now entails the use of over 16,000 trucks, tractors and trailers.

The use of trucks (including tractors, trailers and semi-trailers) in railroad freight-service from 1925 to 1934 is shown in Table 3. A total of approximately 48,000 trucks were used in 1934 by Class-1 railroads and in directly owned trucking companies. No universal policy has been followed. The Eastern District roads have used trucks to a larger extent in terminal transfer and in intercity types of services, while the Western District roads have gone further in store-door collection and delivery service. (See Appendix 3.)

The Railroads' Abuse of Motor Transportation.—In attempting to throttle motor transportation, paradoxically as it may seem in view of their own use of it, the railroads would cut their own enormous revenues from the motor and correlated industries. What this signifies will be appreciated by the figures in Table 4. In "automotive freight" is included all the items making up Table 5, which is a breakdown of the carloads moved in 1933 of the various commodities used for automotive purposes. From petroleum products alone the railroads receive in a single year a greater revenue than they do from all the wheat, oats, corn, tobacco, cotton and potatoes transported in the United States. In the Spring of 1935, the railroads moved 30,000 carloads of freight to and from one automobile manufacturing plant during a four-week period.

The variations in Table 4 present a good picture of business conditions and show distinctly that railroad revenues dwindled because of business and not because of competition. It is also evident that the low point has been reached and that recuperation has begun. It is estimated that 2,930,000 carloads were moved in 1934.

The railroads have been spending considerable money and effort in spreading propaganda which they had hoped would be detrimental to motor transportation. Would it not be far more beneficial if this were directed toward the science of railroading in order to achieve the needed and obviously possible improvements in equipment, operation and service?

A year or two ago, the recommendations of the American Association of State Highway Officials was ridiculed by the railroads, particularly the determination of the gross-weight formula c (L plus 40), with the statement that "no layman and few engineers can understand either the formula or the reason for it, unless it is to make our highway problem more complicated and more difficult to regulate." Engineering formulas have never been evolved with the idea that the layman must necessarily understand them, but the insinuation that engineers cannot do so is so far from the truth that this misleading statement was a travesty on the intelligence of the public, if not a reflection of the limitations of engineering comprehension by the railroad fraternity. The idea that the recommendations of the A.A.S.H.O. would mean increased general taxation is again repeated in the March, 1935, booklet, "Shall We Build Highways for Big Motor Vehicles, or Adjust Vehicles to Highways and Safety Requirements?" This report begins with the statement that the majority report of the U. S. Chamber of Commerce approved the A.A.S.H.O. recommendations, insinuating that this was a calamitous mistake, while the minority recommended that this be left for the individual States to determine. This is a repetition of the conclusions of the Joint Committee on Railroads and Highway Users of Jan. 30, 1933, in which the railroads believed that these matters should be left to the State Regulatory Authority, whereas the Highway Users endorsed the A.A.S.H.O. recommendations. The railroads prefer to deter, harass and strangle motor transportation by conflicting State laws,

Table 5—1933 Automotive Freight 2,640,910 Carloads

	Carloads[a]		Carloads[a]
Motor Vehicles, Parts, Tires	296,010	Crude Rubber	8,900
Gasoline	1,200,000	Asphalt for Roads	47,000
Iron and Steel	120,000	Brick, Vitrified	40,000
Coal	37,000	Cement for Roads, Bridges	152,000
Crude Petroleum	50,000	Gravel, Sand, Stone for Roads	500,000
Lubricating Oil	63,000	Miscellaneous, Such as Non-Ferrous Metals, Paints, Upholstery Materials	78,000
Lumber	14,000		
Road and Fuel Oil	35,000		
Total Automotive Freight Carloads			2,640,910

[a] Partly estimated by the Automobile Manufacturers Association.

[8] See Survey of the Railroad Market for Motor Trucks, Highway Tractors and Trailers; Simmons-Boardman Publishing Co.

and attack it where they are more powerfully intrenched in the individual States.

The assumption is made that all roads and bridges throughout the land, including rural highways, should be capable of bearing maximum loads. There is nothing that has been promulgated by any group interested in roads that has gone on record to the effect that all roads, regardless of traffic density, should be designed and built to take care of maximum conditions.

Considerable data are given on the extent of the increased permissible weights on two and three-axle trucks and trailers and semi-trailers by the recommendations of the A.A.S.H.O., with the attempted idea that these increases are extraordinary and would be wholesale throughout many States. It does not point out what absurdities now exist, nor give any information on what the A.A.S.H.O. recommendations are founded, the indisputable engineering facts, tests and results of research by the profession (including the U. S. Department of Agriculture, Bureau of Good Roads) closest to road construction.

Misleading Impressions Created

The March, 1935, booklet lays great stress on safety, and in which it states "the majority report (of the U.S.C.C.) has given no consideration." What consideration this subject gets in the booklet is by pyramiding incomplete and unrelated facts and premises so that the implication is far from the truth. It is intimated that all loss of life and injuries in all automobile accidents in this country are due to large commercial vehicles. Automobile and truck accidents are not segregated. Fatal "truck accidents" in Delaware are held up as a criterion for the nation. However, no explanation is given as to what kind of accident the truck was involved in. Should a car or a pedestrian run into a truck, which has often occurred, that would result in a truck being involved in an accident. Unless such loosely woven facts are properly qualified, the cloth falls to the ground. No information is given on the type of truck carrier involved. Every safety bureau knows of unusual accident-free records attained by fleet owners.

A document prepared and sponsored financially by the railroads—in this case on the request of the Associated Railroads of New Jersey—is the Ennis Report on "Motor-Vehicle Taxation in New Jersey," in which it is claimed that the cost of highway construction over that of the "basic" highway required by the "basic" vehicle should be assessed against highway transportation of the heavier type. An 18-ft. width is considered sufficient for the basic highway, but modern driving and traffic conditions condemn this width as being unsafe. To this effect, we have such authorities as the U. S. Bureau of Public Roads and the American Association of State Highway Officials. In this document, the author does not properly amortize charges for new construction. The booklet, "The Truth about Motor-Vehicle Taxation in New Jersey," has exploded the myth that the motor vehicle falls short by 18 million dollars of paying its equitable share of highway costs for 1928. It shows that it really has overpaid the actual cost of New Jersey roads by $1,077,000. The assumption that a 5-in. thickness of pavement is adequate for the basic vehicle will be disputed by the Transactions of the Society, and it will be found that climatic and subsoil conditions alone would prevent the use of such light slabs, regardless of impact forces and weight loadings. Pierre Schon has shown[9] where a road entirely free from traffic in the neighborhood of Pontiac, Mich., disclosed breaks and cracks which cannot be attributed to the use of the road.

Many statements of a general nature have been made regarding subsidies accorded motor vehicles. It is impossible to relate them to facts. J. J. Pelley, President of the Association of American Railroads, recently charged that the "Highway Subsidy" from 1921 to 1932 amounted to $7,119,794,000. Several unavailing efforts were made to obtain from the Association of American Railroads the method by which this figure was computed. Whether Mr. Pelley's figures are based on the theory that motor-vehicle owners should pay all the expenses for State and local highways could not be ascertained. However, checking Government figures on all State expenditures for highways against revenue from gasoline taxes and registration fees from 1921 to 1930, it is found that the expenditures exceeded the motor-vehicle special-tax revenue by 7½ billion dollars. If the 7-billion-dollar subsidy was reached by this method, it is based on a fallacious conception of the reasons for the existence of highways. Going back to the early days of the country's history before motor vehicles were even thought of, highways were financed entirely out of general taxation the same as hospitals, schools, and other public institutions.

The national highway system is indispensable to the general national and State interest, national defense, postal service, interstate and intrastate commerce, education, police and fire protection and other elements of general welfare, both of an economic and social nature. Under this set-up it would be inequitable to lay the entire burden of cost of highways on motor-vehicle owners, and this is recognized by those who regard the problem from an unbiased viewpoint.

Practically every impartial student of highway financing has agreed that motor vehicles should be assessed for State or main highways, local roads of general use and arterial routes through cities. Even railroads agreed to this in the Joint Railroads and Highway Users Conference a few years ago. Among other groups subscribing to this principle are: the National Transportation Committee, the U. S. Bureau of Public Roads, the National Tax Association, and the National Highway Users Conference. The justice of this becomes apparent from any survey on the use of State and local highways of the country. One of the most recent surveys was made by the U. S. Bureau of Public Roads in Michigan. This indicated that the local system of highways represented 71 per cent of the total road mileage and on that 71 per cent there traveled an average of 22 vehicles per day per mile. On the county system representing 20 per cent of the Michigan road mileage there traveled 190 vehicles per day per mile. While on the main or State system, representing only 9 per cent of the total road-mileage, there traveled an average of 1144 vehicles per day per mile. From the amount of traffic using them, it is obvious that the use of about 91 per cent of road mileage (county and local combined) is primarily of service to adjacent land. Without them, the farmer consequently could not get his products to market. The adjacent land would be considerably less valuable and 45,000 communities would be without a link to railroad depots.

The conclusion that might also be drawn from the Michigan survey is that there is land-service value in the main roads even as there may be a certain general motoring value in the land-service roads. For the purpose of efficiency in administration, however, as well as a practical distribution of the cost and fair proportion, it would be better if the high-

[9] See S.A.E. Journal, November, 1932, p. 434.

way-users' funds were retained for those roads of general use, so releasing other local funds for local-road use.

The Brooking Institute, in making a study of road taxes for the National Transportation (Coolidge) Committee, made the following statement relative to the relationship between motor-tax revenue and the expenditures for roads of general use:

"We conclude, therefore, that on the whole, highway users are now paying for those highways which are of general use. Local highways are still being paid for, in the main, by local beneficiaries."

Increased Motor-Vehicle Taxes

The U. S. Bureau of Public Roads has drawn substantially the same conclusions. Until some scientific formula is made available by impartial students of taxation as to the amount of highway taxes that should be assessed against motor-vehicle users, real estate and other general taxes, there will continue to exist the situation whereby the opinion of railroad spokesmen is pitted against such authorities as the U. S. Bureau of Public Roads and the National Transportation Committee and others analyzing the problem in the interest of fair play. The ease with which the revenue from motor-vehicle taxation has been collected in some States until the law of diminishing returns has been reached, has been responsible for an increase in motor taxes in the last five years, in face of a general decline in real estate, railroad and other types of taxation. How high taxes affect all types of motor vehicles and motor trucks is indicated in the recent U. S. Bureau of Public Roads' report on motor-vehicle taxation to the effect that:

"There is a noticeable tendency for the taxation imposed on motor vehicles to be relatively high in those States in which the intensity of motor-vehicle ownership is low, as indicated by a relatively large number of persons per vehicle. This condition was particularly noted in the Southern States, where the mileage of roads to be improved and maintained is very large in relation to the number of motor vehicles registered.

"The imposition of unusually high registration fees on heavy vehicles, particularly trucks, in a few States, combined with high gasoline-taxes, has apparently discouraged the registration of such vehicles, with the result that the high rates were productive of little revenue in 1932."

This statement is borne out by the following 19 States which, from 1933 to 1934, reduced registration fees: Arkansas, Delaware, Florida, Idaho, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, Oklahoma, Oregon, South Carolina, Tennessee, Virginia, and Vermont.

The claim of railroad spokesmen to the effect that the rail carriers are contributing substantially toward construction of highways used by their competitors is refuted by a glance at the facts. Aside from taxes they pay on motor vehicles they own, the same as other highway users, the only means through which railroads contribute to the highways is in money derived from Federal and State general funds for roads. Of the total funds turned over from general taxes for roads, railroads contributed only 1.5 per cent.

A substantial portion of this 1.5 per cent is devoted to expenses of local roads which are not generally used in competition with railroads. As a matter of fact, these local roads definitely benefit by serving as feeders in transporting each year millions of tons of freight to rail heads from communities not served by rail lines. The Interstate Commerce Commission says that there are 45,000 communities in this country without railroad service. When this phase of the situation is analyzed, coupled with the fact that railroads themselves are using 48,000 trucks, it is apparent that the negligible amount of rail taxes that go into highway improvements is not a gift to rail competitors.

Table 6—Comparative Taxation

Railroads

Year	Railroad Property Investment[a]	Total Railroad Taxes[a]	Tax Rate Per $1000 Property Investment
1920	$20,467,057,560	$272,061,453	$13.30
1921	21,925,988,630	275,875,990	13.20
1922	21,200,095,412	301,034,923	14.20
1923	22,204,659,379	331,915,459	14.90
1924	23,031,861,420	340,336,686	14.77
1925	23,629,679,731	358,516,046	15.17
1926	24,291,466,166	388,922,856	16.00
1927	24,809,229,637	376,110,250	15.16
1928	25,233,550,064	389,432,415	15.43
1929	25,870,122,983	396,682,634	15.30
1930	26,354,686,261	348,553,953	13.20
1931	26,242,856,220	303,528,099	11.56
1932	26,152,160,332	275,135,399	10.50
1933	25,942,000,000	249,602,895	9.60

Motor Vehicles

Year	Total Vehicles Registered in U. S. A.	Yearly Tax Bill	Average Tax Per Vehicle
1927	23,133,243	$688,373,653	$28.89
1928	24,493,124	716,887,967	29.27
1929	26,501,443	849,155,062	32.04
1930	26,657,012	920,388,270	34.53
1931	25,993,896	948,735,112	36.50
1932	24,341,822	986,992,942	40.55
1933	23,849,932	1,137,872,176	47.70
1934	24,751,644	1,214,000,000	49.04

[a] From Railroad Handbook of Information.

Property and Taxes

After having seen how small a percentage of railroad taxation is used for road construction and whose feeder service is worth a good many times more to the railroads, it might be of interest to investigate how they have fared in recent years on their "excessive" property taxes. In Table 6 it will be seen that the tax rate paid per $1,000 of property investment increased slightly during the boom years and then declined most rapidly during the depression. Starting with $13.30 in 1920, the rate in 1933 was only $9.60 per $1,000. In the case of the motor vehicle, the average tax per vehicle has risen from $28.89 to $49.04 in 1934. These figures represent increases for the average vehicle; they are considerably more for commercial vehicles and buses. It will be seen that, in spite of the decline of registration in the lean years, the average tax rose at an increasing rate.

The railroads own their own private rights-of-way; the roads are public property. Taxation derived from ownership of property is basic. The roads and their cost of maintenance have been paid for. The public can use them and have access to them so long as it does not interfere with or endanger the regular flow of traffic thereupon. Access to railroad property is absolutely prohibited. Motor transportation is not only paying its way, but is assessed unjustly by the divergence of taxes for uses other than road construction or maintenance. In only a very few States are there constitutional prohibitions against such misuse.

In talking of "Subsidies" one is reminded of the gift of 178,371,539 acres of land given to the railroads years ago for their private rights-of-way, not to mention moneys appropriated by individual States. A typical example might be cited:

"The Legislature of Illinois appropriated $10,237,000 on Feb. 27, 1837, to launch the internal-improvement schemes. This imposed a debt of $34.10 per capita upon the scanty population of poor, hard-working pioneers at a time when the State was already in debt and without sufficient revenues to meet current expenses. Chicago was then a village of 1470 inhabitants and had to have a garrison to protect it from Indians. In 1838, the legislature appropriated $5,000,000 more[10]."

Uniform Codes and Motor Transportation

Due to the widespread use of motor transportation, the desirability of uniform codes is axiomatic. The existence and effect of wide variations in State legislation have been clearly expounded on numerous occasions by Pierre Schon, whose "flexible" truck has exposed some of the follies of measures, the extremes of which have no rhyme nor reason. Much still remains to be done along these lines. While the States have their inherent rights and have been upheld in their power to legislate minutely on matters pertaining to motor transportation, there is no justification for the many variances that now exist and which have even no foundation on local conditions. The manufacturing industry has suffered considerably in attempting to produce vehicles in keeping with the kaleidoscopic changes throughout the country so that a vehicle which is lawful to operate in one State will not be an offender when it crosses a State line. I doubt if there is any industry which has been subjected to more legislative changes and ever-tightening restrictions.

The multiplicity of conflicting regulation affecting buses is of considerable concern to the manufacturers, the users and the public in turn, since the specifications written by the various regulatory bodies, both State and municipal, vary on inconsequential matters and make it almost impossible to produce two differently located buses under the same specifications. This entails an increased cost right down the line.

These regulations affect, among others, such items as the emergency door for location and size, service doors, signal devices, bumpers, ventilation, heating, exhaust-pipe arrangement, brake-performance specifications, lighting equipment, location of markers, color of marker lenses, location, arrangement, number and colors of reflectors; use of right-turn and left-turn indicators; stoplights, mirrors, seating arrangements and spacing, aisle widths, overall lengths, overhang, heights, widths, weights, etc. Very often the specifications for ventilation and heating will state that each omnibus shall be equipped with "proper and sufficient" ventilators or heaters. It has been found that many of the regulatory authorities are unable to state what "proper and sufficient" devices should consist of and manufacturers are at a loss to know how to cover the situation other than to submit one system after another until final approval is obtained. Such methods are time consuming and costly. To fill an order for some buses operating through several States, one manufacturer found it necessary, in complying with the various laws, to install a total of 13 red lights or reflectors, including the usual tail light and stoplight.

The American Association of State Highway Officials' recommendations have always been founded upon unquestionable scientific data. The increasing adoption by different States has helped considerably in the direction of uniform requirements. For the purpose of a national defense, their enactment is tremendously desirable.

A very valuable national service has been accomplished by the National Conference on Street and Highway Safety, Department of Commerce, in establishing five acts comprising the Uniform Vehicle Code, as approved in its present form by the Fourth National Conference at its meeting in Washington, D. C., May 23 to 25, 1934, comprising:

I. Uniform Motor Vehicle Administration, Registration, Certificate of Title and Anti-theft Act.
II. Uniform Motor Vehicle Operators' and Chauffeurs' License Act.
III. Uniform Motor Vehicle Civil Liability Act.
IV. Uniform Motor Vehicle Safety Responsibility Act.
V. Uniform Act Regulating Traffic on Highways.

On the subject of accidents, it is interesting to quote from the "Guides to Traffic Safety," which states:

"A year-by-year comparison since 1927 shows that there has been no increase in the number of commercial-vehicle drivers involved in fatal accidents, whereas the private-car operators involved in fatal accidents have advanced about 46 per cent during the seven years. Truck-driver accidents are reported to have declined 2 per cent, bus-driver accidents declined 24 per cent, and those involving taxicab operators 43 per cent."

Besides fostering education for the general public on the subject of traffic safety, the Conference has been instrumental in bringing the subject into the elementary and high schools so that the automotive-minded coming-generation shall be instilled with the desired and necessary consciousness of safety. The subject is made of great interest to the children, not only on the safety angle, but also in teaching the general principles of automotive construction and operation. This fits admirably into high-school work, since an analysis of the automobile can be correlated with the students' work in physics and chemistry. One New Jersey city has the cooperation of the local police and the Motor Vehicle Commissioner so that the student will be eligible for a driver's test at the close of his high-school course, the written examination being eliminated in lieu of the course taken by the student.

What of the Future?

Motor transportation is firmly intrenched because of its inherent merits. At the moment, it seems a very distant day when a better, faster, or more economical medium might supplant it except for very special cases.

In view of the widespread and representative national interests which are against over-regulation of motor transportation, it would not appear that it will be unrightfully strangled.

[10] See Report of the Joint Commission of Agricultural Inquiry, Part 3, 1922.

Should temporary upsets arise, it will eventually win out, since its very existence and reception are founded on its basic advancement in the line of progress and its indisputable ability to accomplish what has not been possible heretofore. No one can stop evolution.

Appendix 1

Comments[11] *on the "Motor Carrier Act", 1935.*—It has been pointed out frequently that the reasons behind and the causes that brought about the regulation of the rail carriers do not exist, nor can they ever pertain to the motor-carrier industry in its present form of competitive independence. The ramifications of the motor-carrier service are too broad in their extent. Hundreds of thousands of persons are engaged independently and individually in its performance, and these facts constitute an eradicable warranty of public protection against the evils that forced an outraged people to demand the regulation of the railroads.

Harold S. Shertz, representing the American Trucking Associations, Inc., said: "The truck industry is non-monopolistic. Through its variety of methods of performing transportation service, the industry remains at the level most desirable in public interest." Some of the possible intricacies that might arise with a small operator are to be found under Exceptions (Section 303b) in which the casual or occasional transportation of persons or property in interstate or foreign commerce for compensation by any person not regularly engaged in transportation by motor vehicle as his or its principal occupation or business may be subject to I.C.C. regulation to the extent that the Commission shall from time to time find that such application is necessary to carry out the policy of Congress enunciated in Section 302. In other words, if the Commission is of the opinion that such casual or occasional transportation service is interfering with or in competition with certified or permitted operations, or with the operations of a rail carrier, it may assume full regulatory powers over them.

Under this Section a farmer owning a truck transports an occasional load of hogs or apples for his neighbors to town or to a nearby market for compensation. This service may be performed several times during the shipping season. A railroad or other carrier may complain to the I.C.C. that he is operating irregularly and more than occasionally or casually. He will have to come in and defend. He will have to prove that his service is only casual or occasional. Is twice a month or twice a year occasional? Is four times one month and ten times the next month casual? Is it right that such a man be made subject to the necessity for defending himself in court under the penalty section?

Section 305(e) authorizes the taking of testimony by deposition and forebodes the elimination of the "little follow." In view of the legal set-up of the railroads, with an attorney in every county-seat town, the use of this authority may very easily become burdensome and prohibitive to the little truck operator. He could be subjected to the expense, time and great inconvenience of being obliged to go to many different points in the country to participate and cross examine in deposition proceedings.

In regard to Powers of the Commission, Section 304 clothes the Interstate Commerce Commission with general powers of regulation, including the promulgation of rules, regulations and procedure; the establishment of classifications of groups of carriers; action upon complaints or upon its own initiative; investigations; decisions; and the execution and enforcement of its orders. Application for reconsideration or rehearing shall be governed by such general rules as a Commission may prescribe. The I.C.C. may call upon any other Federal agency for statistics and data.

It must be remembered at all times that the regulation of motor carriers of property is inherently different in many respects from the regulation of rail transportation. In dealing with the railroads, there are comparatively few corporations. Their lines are fixed and their service is well established. There are more than 300,000 For-Hire trucks operating in the country, under the management of some 200,000 operators. The truck lines are subject to constant and instant changes. The service is elastic in the extreme. Truck operations are not, in the vast majority of instances, between depots. In most instances, they are from the place of business of the consignor to the place of business of the consignee. Time schedules are incidental, and service to off-route points is frequently performed. This remarkable relationship between the trucker and his patron has developed to a remarkable degree. This relationship provides the performing of personal services, in conjunction with the transportation, which have become an integral part of motor carriage. Any attempt to stifle this relationship or restrict these services would be unprogressive and reactionary.

The attempted enforcement by the several States of the use of Railroad Classifications by truck operators has proved entirely without force or effect. The utter inability of the average truck operator to conform to or abide by such Classifications is well known. It is equally well known that these Classifications are sources of constant disagreement and misunderstanding among railroad agents themselves. If through routing, through rates, through and uniform billings over joint rail and truck hauls are to be required, then Rail Classification may be reasonably expected for truck application. It simply cannot be enforced.

Section 305-(b) states: "Whenever operations involve not more than three States the Commission shall, and whenever more than three States are involved, the Commission may, refer to joint boards for hearings and recommendations (1) on applications for certificates or permits; (2) suspension, change or revocations of certificates or permits; (3) consolidations, mergers and acquisitions; (4) complaints of violations; (5) complaints as to rates, fares and charges; (6) approval of bond or insurance coverage; and (7) it may refer investigation and suspension proceedings, or other matters not specifically mentioned."

"A joint board shall be composed of one member from each State within which the motor-carrier operations are involved, in such matters as are to be so referred. An examiner may be designated by the I.C.C. to advise with and assist such joint board. (c) If a joint board is not appointed, does not qualify or fails to act, the I.C.C. may consider all matters that should have been referred to such joint board. (g) The Commission may confer with or hold joint hearings with State authorities in connection with any matters arising in any proceedings under this part, and may avail itself of the cooperation, services, records and facilities of such State authorities. (h) Any final order made under this part is subject to the same right of relief in court as now provided in respect to other Commission orders."

The law thus provides for the reference of many administra-

[11] See "A Digest of the 'Eastman' Motor Vehicle Regulatory Bills", February, 1935; National Highway Users Conference.

tive questions to a Joint Board composed of representatives of local State Commissions, and thereby reduces much of the first cost of securing a certificate, or of other administrative action, by having it acted upon and the hearing held at a point within or adjacent to the applicant's home State. The practice provided under the Bill, however, makes any action or order taken by a Joint Board subject to review by the I.C.C. The procedure allows re-hearings and re-arguments in proper cases following the filing of exceptions by any interstate party. For example: An applicant for a certificate to operate between Cheyenne, Wyoming, and Fort Collins, Colorado, receives, after hearing, an order by the Joint Board, authorizing the issuance of the certificate. A complete railroad, deeming itself aggrieved, may file exceptions and the cost of carrying on the litigation before the I.C.C. might in itself very easily become prohibitive to the little operator.

In addition to the cost to the applicant, or other party concerned, there is also the problem of great delay. As Mr. Eastman has said in his Hartford address (supra):

"One of the sound criticisms of public regulation of railroad and public utilities as it has been practiced in this country is the time it takes. It has been characterized too often by prolonging litigation of issues and by ponderous and burdensome procedure. I see no escape from much of this. It is inherent in the system."

A rate in effect across two States is to be changed. That rate on its face only involves two States and "shall" be referred to a Joint Board for hearing. But that rate change would be reflected in the total rate of through routes clear across the continent, or across many States. Would it be referred to a Joint Board?

Granting and Issuing of Permits

The granting and issuing of permits—Section 309-(a)—will be done when consistent with the public interest, is in the discretionary power of the Commission, if after hearing it may determine that the applicant is fit, willing and able to properly perform the service of a contract carrier and to conform to the requirements, rules and regulations, and the proposed operation will be consistent with the public interest and the policy declared in Section 302-(a). In determining what is consistent with the public interest, the Commission undoubtedly will give full consideration to the service performed by existing railroads or other carriers, and if it finds the existing service to be adequate it may and no doubt will deny the application. Such power conveys the right to restrict private carriage and to curtail the right of private contract.

Permits for contract carriers will be required under this definition for the truck operator who is engaged in transporting livestock or farm products from the farm to the primary market, if such movement crosses a State line. Fred Brenckman, representing the National Grange, points out that contract carriers, the majority of which are small operators with 1-ton and 2-ton trucks, perform a vital service for the farmer in their willingness to go anywhere at any time and for compensation which is mutually agreed upon. If the full intent of the present regulatory efforts is carried out, this type of operator will be destroyed. The contract carrier has neither the means nor the time to untangle the red tape that would necessarily follow if he were placed under a single regulatory body.

Dual Operations.—Section 310 states: "No person shall at the same time hold a certificate as a common carrier and a permit as a contract carrier for the same route or within the same territory unless the Commission finds it to be within the public interest." W. H. Brusche, acting manager, traffic board, Merchants Association of New York City, stated that some of the largest and most responsible common-carrier organizations in the New York area are equipped to perform contract-carrier operations efficiently, but are precluded under the proposed regulatory measures preventing the performance of both services. This rule is now in effect in some States. It has merely resulted in many cases of separate dummy corporations being formed to take care of the other class of service.

Section 312 states: "Certificates, permits and licenses shall remain in effect until terminated upon application of the holder or after hearing upon complaint for cause. There can be no serious objection to the requirement of a certificate of convenience or necessity, nor to the right of the issuing agency to retain control of its continuance, except for the possibility of burdensome requirements that may normally be expected to follow such power of control. Complaints may be filed at any time, and upon almost any actual or fancied irregularity of action. Such complaints will have to be met, and their prosecution combated. Should the railroads embark upon a program of filing complaints, we may look for a constant stream of motor carriers, their lawyers and representatives, into Washington, at least as long as the truckers' money lasts".

Highway-Transport Competition Desirable

Under present conditions, monopoly in the highway-transportation field is utterly impossible unless brought about by legislation, for there is no business more keenly competitive. The proposed regulations would induce it. Section 316 (b) states: "It shall be unlawful for any carrier to give or cause any undue or unreasonable preference or advantage to any particular person, port, gateway, locality or description of traffic in any respect whatsoever or to subject it or them to any unjust discrimination or any undue or unreasonable prejudice or disadvantage."

A local operator performing accommodative services for his patrons will very likely find that such services are considered preferential, discriminatory or prejudicial. The vast majority of motor carriers today have built up the bulk of their patronage through the furnishing of these personal services. They include many services which apparently cannot be performed by railroad companies. If this trucker be operating wholly intrastate and if it be shown that he is in competition with a carrier, some of whose operations are interstate, under Section 302 (c), the Commission would have authority to force the discontinuance of this so-called disadvantage or prejudice.

These services, which frequently include solicitation, the transporting of property unpacked, the ordering and selecting of merchandise, the payment therefor, door-to-door pickup and delivery, the return of merchandise with directions for exchange, etc., have become a widespread and integral part of motor-carrier service as performed by the majority of motor carriers. The curtailment of this service would surely be against public interest.

A proper basis of computing a proper and lawful basis of motor-carrier rates for the transportation of property has not as yet been devised anywhere. Even after a century of railroad transportation, a schedule of railroad rates based upon cost has not been obtained. Motor-carrier costs are so varied, and so many different arrangements enter into each piece of service rendered, that it has so far proved to be impossible of general application. Two vehicles identical in every particular, operating over the same roads and for comparable mile-

ages, may vary considerably as to cost per ton per mile. Varying conditions of roads, varying tonnages, and many other factors must enter into what will constitute a reasonable rate.

Section 316 (c) covers the power to fix rates and states: "Any person, State board, organization or body politic may make complaint in writing to the Commission. The Commission may after hearing, upon complaint, or in an investigation or on its own initiative, issue appropriate orders. It may establish through routes, joint classifications, joint rates, fares, charges, regulations, or practices. It shall determine and prescribe the lawful rate, fare, or charge for the maximum or minimum, or maximum and minimum rate, fare, or charge thereafter to be observed."

Any person, and this would include any railroad company or other competing carrier, may make a complaint to the I.C.C. making it necessary for the little local operator to respond to and defend his services and rates. These offensive actions very easily may become so burdensome as to force him out of business entirely. Whenever the railroads are placed in a position, through the bringing of discrimination cases, to establish the minimum rates of buses and truck carriers, the motor carrier will cease to live.

Regulation Must Not Destroy Competition

Section 316 (e) requires that: "Any schedule stating a new individual or joint rate, fare or classification, or rule or regulation, must be filed with the Commission. Upon complaint, or upon its own initiative, the schedule may be suspended for hearing and investigation." Chester H. Gray, representing the American Farm Bureau, states: "No one method of transportation, old or new, as the case may be, should be permitted to be taken as a yardstick to measure other methods of transportation old or new. Federal law should not attempt to force all types of transportation to assume a common level. Our highway system represents an investment of billions of dollars and no method should be devised for measuring its benefits according to the effect it has on other means of transportation".

Agriculture needs the greatest possible benefits in rates and services from any transportation agency, and the competition providing such benefits must not be destroyed by regulation. "The motor vehicle is a necessity to agriculture, and cannot be classed as a luxury; accordingly, it must not be crowded off our highways by prohibitive limitations, regulations and charges."

An unavoidable tendency, Mr. Gray pointed out, for any such regulation of the motor vehicle, especially under a single administrative agency, would be to bring motor-carrier rates to an equality with railroad rates, and would require motor vehicles to conform to railroad services. General protection of public interest and safety should be the only consideration in such a regulatory policy.

W. J. Campfield, secretary, Eastern Apple Growers' Council, states: "The motor vehicle has developed because there existed an economic need for this type of transportation. It is cheaper, more efficient, more flexible and its mechanical application makes it thoroughly practicable. Through it the high cost of transportation is being solved, and greater distribution of farm products is possible. If the motor truck is allowed to grow unimpeded, a reorganization of our present inefficient system of marketing and distribution of perishables will result."

Charles W. Holman, National Cooperative Milk Producers' Association, states: "A grave injustice would be done to farmers if rates are regulated upon the principle of protecting a competitor, rather than on the cost of service. Many of the railroad factors such as over-capitalization, gigantic bond issues, and heavy operating charges are not involved in the trucking industry and, in addition, truck costs vary with conditions to such an extent that the only equitable basis is the value of the service to the truckman and to the farmer. Adjustment of the rates to the railroad scale cannot possibly be of benefit to anyone but the railroads."

A. M. Loomis, representing the American Association of Creamery Butter Manufacturers, states: "Even if the power of the Federal Government is interposed to compel creameries to pay the same rates for their truck service as the railroads are charging, the creamery-butter industry would still use motor vehicles in its operation and the railroads would gain nothing in that direction from their campaign to force traffic back to the rails. The motor industry represents progress, and any effort to interfere with it is attempting to change the course of progress."

With the right to suspend a Motor Carrier rate for a period of 90 days, upon complaint, the result will be crucifixion of the carrier. Many such reductions would be for seasonal service, and the season would be over before the suspension could be lifted or adjusted by hearing and order.

Fred Brenckman, representing the National Grange, states: "The farmer has in many cases taken to the truck as a means of self-preservation from the exorbitant rates of the railroads. The motor vehicle has been instrumental in widening the farmer's market and in bringing him increased financial returns."

Arthur M. Hill, president, National Association of Motor Bus Operators, and also president of the Atlantic Greyhound Lines, states: "Mr. Hill's organizations have consistently advocated the passage of a bill regulating interstate bus operations. He seriously questions, however, the advisability of giving complete rate-making powers over motor vehicles to the Commission. He believes it possible that the motor-carrier rates would be strictly curbed, and the railroads would be allowed to put in any rate, on a theory that it was justified by competition."

Appendix 2

Text of the Amendments to Section 1629 Approved by the Senate in Passing the Bill.—In Section 202 (a), Declaration of Policy and Delegation of Jurisdiction, the words "supervise and", at the beginning of the Section, were stricken out.

In Section 202 (c), the closing phrase "except where and only to the extent that such regulation causes undue or unreasonable disadvantages or prejudice to persons and or localities in interstate commerce", was stricken out.

In Section 204 (a), General Duties and Powers of the Commission, the words "supervise and" were stricken out in subdivisions (1), (2) and (4).

In Section 204 (b), the final words, "is in conflict or inconsistent with any action under the provisions of this part", were inserted between the words "which" and "shall" just preceding. With this correction, the completed phrase read as follows: " . . . which is in conflict or inconsistent with any action under the provisions of this part, shall have no force or effect after this section becomes effective."

In Section 212 (b), Suspension, Change, Revocation and

Transfer of Certificates, Permits and Licenses, after the phrase "within a reasonable time", there was inserted "not less than 90 days". The part of the Section then read: ". . . within a reasonable time, not less than 90 days, to be fixed by the Commission, . . . etc."

In Section 223, Collection of Rates and Charges, after "to govern the settlement of all such rates and charges", there was inserted the phrase "including rules and regulations for weekly or monthly settlement". This made that part of the Section read: ". . . to govern the settlement of all such rates and charges, including rules and regulations for weekly or monthly settlement, and to prevent unjust discrimination . . .", etc.

In Section 225, Investigation of Motor-Vehicle Sizes, Weights, and So Forth, the words "and of any organization of motor carriers", appearing at the end of the Section, were placed after the word "Government", making that part read: ". . . all departments or bureaus of the Government and of any organization of motor carriers having special knowledge of any such matter."

Appendix 3

Trucks Used by Railways in Freight Service; Eastern District[a]

Railroad	Term. Trans. Service	No. of Trucks	Intercity Service	No. of Trucks	Store-Door Service	No. of Trucks
Baltimore & Ohio	Yes	500	Yes	100	No	...
Bangor & Aroostook	No	...	No	...	Yes	50
Boston & Maine	Yes	120	Yes	90	Yes	300
Central of New Jersey	Yes	20	Yes	10	Yes	5
Central Vermont	No	...	Yes	6	Yes	40
Chi. & Eastern Ill.	Yes	30	No	...	No	...
Chi., Indpls. & Louis.	Yes	10	No	...	Yes	100
Delaware & Hudson	No	...	No	...	No	...
Del., Lack. & Western	Yes	30	Yes	1	No	...
Erie	Yes	400	No	...	Yes	450
Grand Trunk Western	No	...	No	...	Yes	150
Lehigh Valley	Yes	23	Yes	1	No	...
Long Island	Yes	10	Yes	5	Yes	200
Maine Central	No	...	Yes	5	Yes	94
New York Central	Yes	2,000	Yes	500	No	...
N.Y., Chi. & St. L.	Yes	300	No	...	Yes	350
N.Y., New Haven & Hart.	Yes	40	Yes	150	Yes	41
Pennsylvania	Yes	1,750	Yes	75	Yes	4,000
Pere Marquette	Yes	20	Yes	2	Yes	250
Pittsburgh & Lake Erie	Yes	6	Yes	3	No	...
Reading	No	...	Yes	56	Yes	6
Rutland	No	...	No	...	Yes	20
Wabash	Yes	250	No	...	Yes	100
Western Maryland	No	...	No	...	No	...

Summary

Out of 24 Roads in the Eastern District:

16 roads use 5,509 trucks in terminal transfer service

14 roads use 1,004 trucks in intercity service

16 roads use 6,156 trucks in store-door-delivery service

[a] From Simmons-Boardman Publishing Co.'s "Survey of the Railroad Market for Motor Trucks, and Highway Tractors and Trailers."

Trucks Used by Railways in Freight Service; Southern District[a]

Railroad	Term. Trans. Service	No. of Trucks	Intercity Service	No. of Trucks	Store-Door Service	No. of Trucks
Atlantic Coast Line	Yes	100	No	...	No	...
Central of Georgia	Yes	50	Yes	4	No	...
Chesapeake & Ohio	No	...	No	...	Yes	250
Florida East Coast	No	...	No	...	Yes	75
Illinois Central	Yes	100	No	...	Yes	300
Louisville & Nashville	Yes	120	Yes	2	Yes	750
Nash., Chatta. & St. Louis	Yes	30	No	...	Yes	200
Norfolk & Western	No	...	No	...	No	...
Norfolk Southern	Yes	5	No	...	No	...
Richmond, Fred'burg & Pot.	Yes	1	Yes	2	Yes	1
Seaboard Air Line	Yes	50	Yes	1	No	...
Southern	No	...	No	...	No	...

Summary

Out of 12 Roads in the Southern District:

8 roads use 456 trucks in terminal transfer-service

4 roads use 9 trucks in intercity service

6 roads use 1,576 trucks in store-door-delivery service

[a] From Simmons-Boardman Publishing Co.'s "Survey of the Railroad Market for Motor Trucks, and Highway Tractors and Trailers."

Trucks Used by Railways in Freight Service; Western District[a]

Railroad	Term. Trans. Service	No. of Trucks	Intercity Service	No. of Trucks	Store-Door Service	No. of Trucks
Alton	Yes	30	No	...	Yes	25
Atchison, Topeka & Santa Fe	No	...	Yes	20	Yes	600
Chicago & Northwestern	Yes	100	No	...	Yes	50
Chicago, Bur. & Quincy	Yes	60	No	...	Yes	450
Chicago Great Western	Yes	25	No	...	No	...
Chgo., Mil., St. Paul & Pac.	Yes	100	Yes	10	Yes	50
Chicago, Rock Island & Pac.	Yes	30	No	...	Yes	650
Chgo., St. Paul, Mpls. & Omaha	Yes	45	Yes	35	Yes	10
Colorado & Southern	No	...	No	...	Yes	150
Denver & Rio Grande West.	No	...	Yes	20	Yes	150
Great Northern	Yes	50	No	...	Yes	100
Kansas City Southern	Yes	25	No	...	Yes	200
Minneapolis & St. Louis	Yes	20	No	...	Yes	5
Mpls., St. Paul & S. S. Marie	Yes	30	No	...	No	...
Missouri-Kansas-Texas	Yes	100	No	...	Yes	900
Missouri Pacific	Yes	250	Yes	15	Yes	1,200
Northern Pacific	Yes	50	Yes	2	Yes	100
St. Louis-San Francisco	Yes	120	No	...	Yes	500
St. Louis Southwestern	Yes	50	Yes	60	Yes	300
Southern Pacific	Yes	70	Yes	100	Yes	2,800
Spokane, Portland & Seattle	Yes	5	No	...	Yes	150
Texas & Pacific	No	...	No	...	Yes	385
Union Pacific	Yes	30	No	...	Yes	300
Western Pacific	Yes	20	No	...	Yes	50

Summary

Out of 24 Roads in the Western District:

20 roads use 1,210 trucks in terminal transfer-service

8 roads use 262 trucks in intercity service

22 roads use 9,125 trucks in store-door-delivery service

[a] From Simmons-Boardman Publishing Co.'s "Survey of the Railroad Market for Motor Trucks, and Highway Tractors and Trailers."

A Forgotten Property of Gasoline

By J. O. Eisinger and D. P. Barnard
Research Laboratory, Standard Oil Co. of Indiana

IT is recognized that volumetric efficiency—and therefore specific output — can be increased by reduction in manifold temperature, pressure drops, and the like. The present investigation has been directed at the determination of the changes in volumetric efficiency which may be obtained by fuel-volatility variations. The results of this work may be summarized briefly as follows:

(1) Very substantial improvement in engine performance can be obtained by taking advantage of suitable volatility increases.

(2) A given degree of improvement in the distribution characteristics of a fuel can be attained by combining "front-end" and "total" volatilities in a fairly varied manner.

(3) The distribution characteristics of a gasoline can be judged satisfactorily by using the amount evaporated at 158 deg. fahr. (A.S.T.M.) as a measure of "front-end" volatility and the temperature of the 90-per cent evaporated point as an index of "total" volatility.

(4) It is possible to attain a marked degree of distribution improvement without resorting to extreme variations in either "front-end" or "total" volatility.

(5) It appears that volatility improvements (properly chosen) constitute a real opportunity for increasing the usefulness of automobile fuels.

(6) The improvement in the volatility characteristics of gasolines during the last four years has been much more marked than that which occurred during the entire ten years prior to 1931. The increasing and more intelligent application of the seasonal adjustment of fuel volatilities is indicated to be of real worth to the car operator. The actual value of "weather-wise" gasoline in the operation of a car is not generally appreciated but will become an increasingly important factor in induction-system design and improved engine-performance.

IT is well recognized that the physical and chemical characteristics of gasolines have varied markedly since the advent of the automobile. These variations, until recently, have been dictated by economic conditions rather than by the automobile engine. The extent of these variations can be appreciated by an inspection of Fig. 1, which traces the trends of the more important volatility factors[1]. Some of the important developments influencing these variations are also indicated. Complete distillation curves of fuels representative of some of the more important periods[2] are given in Fig. 2. The values given in Figs. 1 and 2 from 1920 to date are "normal" or "average" based on a considerable number of samples of different brands of "regular" gasolines.

The following investigation was undertaken to determine some of the possible differences in automobile performance which may be realized through the medium of fuel-volatility changes. The point of principal interest lay in the relation between such volatility changes as might be indicated by variations in the A.S.T.M. 90-per cent point, per cent off at 158 deg. fahr., etc., and the engine performance resulting when corresponding intake manifold and carburetor modifications were made. The bulk of the work described was done on the road with a single car, and the manifold changes, which consisted principally of temperature changes, were carried out in the simplest manner possible. They do not necessarily represent "best-power" conditions, but rather consist in temperature and mixture-ratio alterations applied to a single existing (and standard) manifold. Vapor lock, starting, dilution effects, etc., were not considered as being within the scope of the investigation.

Experimental Procedure

(1) *Method of Test.*—It was decided that results of direct applicability to automobiles in service would be preferable to

[This paper was presented at the Semi-Annual Meeting of the Society, White Sulphur Springs, West Va., June 20, 1935.]

[1] See Twenty-Third Semi-Annual Gasoline Survey, part i, R. I. 3129, August, 1931. See also *Oil and Gas Journal*, Jan. 24, 1935, p. 12; "Quality of Premium and Regular Gasolines Better but Third Grade Drops", by W. T. Ziegenhain. See also Federal Specifications for Gasoline; Motor, U. S. Government VV-G-101, July 21, 1931.

[2] See Federal Specifications for Motor Fuel V, VV-M-571, July 21, 1931. See also U. S. Army Specifications, Fighting Grade, Y-3557-H, April 15, 1935.

those which might be obtained in the laboratory. Accordingly, virtually all of the work was done on the road with a (then current) 1931-model Buick 7-passenger sedan, care being taken to keep all car factors such as weight, rolling resistance, etc., as constant as possible. The more important points of the work have been verified upon certain other and more recent car models; but, as the results obtained were relatively similar, the data obtained with the 1931 car only are reported here. In addition, this car was particularly well adapted to work demanding manifold temperatures controllable over a wide range.

The general principle followed in this investigation consisted in first determining the effect of manifold temperature on car performance, and then, setting the manifold temperature at some pre-selected value and determining the best acceleration performance possible at that temperature with each fuel. The knock rating of the fuels was raised to a value high enough (75 octane number) to preclude the possibility of detonation effects. The actual tests consisted in observing the time required to accelerate from 10 to 38 m.p.h. up the uniform 5.5-per cent grade shown in Fig. 3. The reason for using the grade is based on the fact that small differences in brake horsepower of the engine will show up as comparatively large percentage-differences in reserve power, which are inversely proportional to the time required to accelerate from one speed to another. This relatively large percentage-increase in power available for acceleration for a given improvement in engine output can be appreciated by an inspection of Figs. 4 and 5. When Fig. 4 is compared with Fig. 5, which shows respectively the magnitude of the reserve power when accelerating on the level road and the test hill, it is rather obvious that a given difference in engine output will be magnified by hill tests. Thus, a 5.0-per cent increase in brake horsepower of the engine at 24 m.p.h. (the average speed during these tests) will show up as a 5.4-per cent increase in the reserve power on a level road, and an 8.4-per cent increase on the grade.

The advantages of hill tests in this and similar work where it is necessary to detect small changes in brake horsepower can probably be best appreciated from an example. On the level road under normal conditions the test car could accelerate from 10 to 38 m.p.h. in about 15 sec. On the hill, it required about 30 sec. to accelerate over the same speed range and a 1.0-sec. difference between individual observations would lead to only a 3.3-per cent error in the hill tests. This error was reduced further by making several check observations under each set of conditions.

Several trips up and down the hill were made following the definite test schedule, before any records were taken. This was done to bring engine-operating temperatures to normal for the conditions of test. The actual speeds of the car were determined by a fifth wheel and suitable tachometers (Fig. 6), which had been previously calibrated. Thermocouples were located at various places in the intake manifold walls as indicated in the schematic diagram shown in Fig. 7. Other thermocouples were located at various places in the engine, such as the crankcase sump, water outlet, intake air, etc. The major part of this investigation, however, deals with intake-manifold wall-temperatures which were varied by controlling the amount of exhaust gases entering the hot spot, by the amount of cold air taken to the carburetor intake, etc. Manifold wall temperatures have been used instead of what are sometimes called "mixture temperatures." The latter are virtually impossible to determine accurately because of the

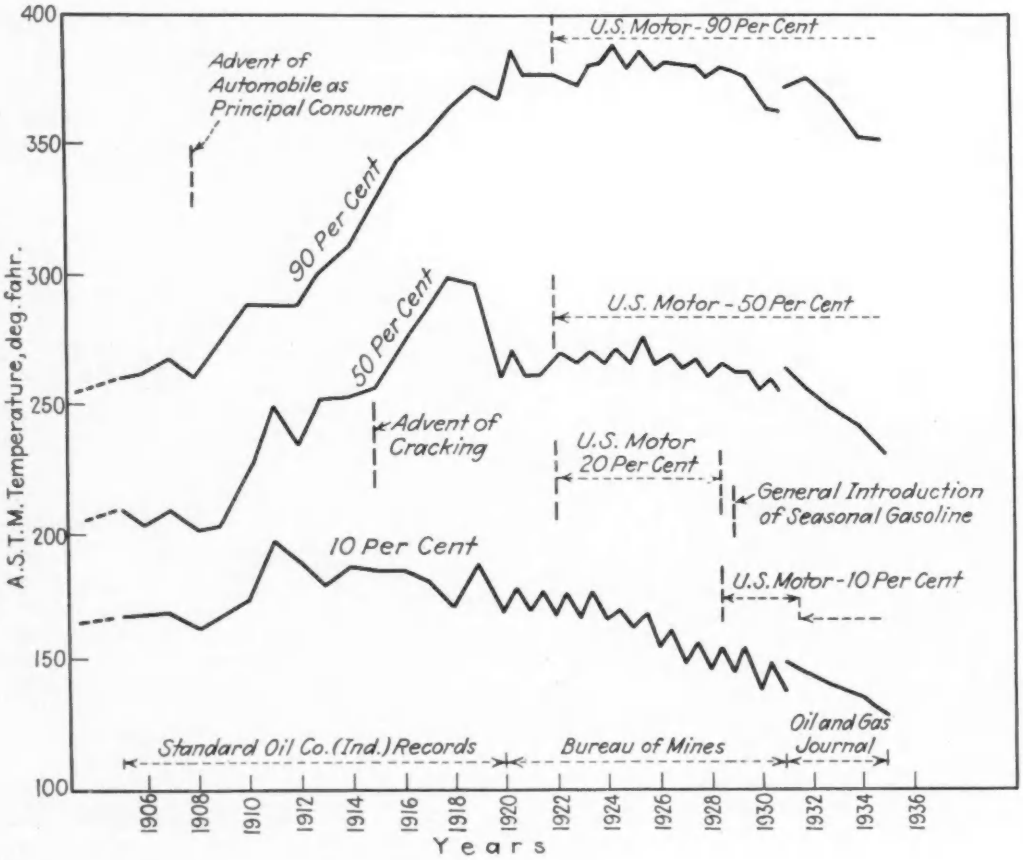


Fig. 1—Trends of the More Important Volatility Factors; Record of A.S.T.M. Characteristics

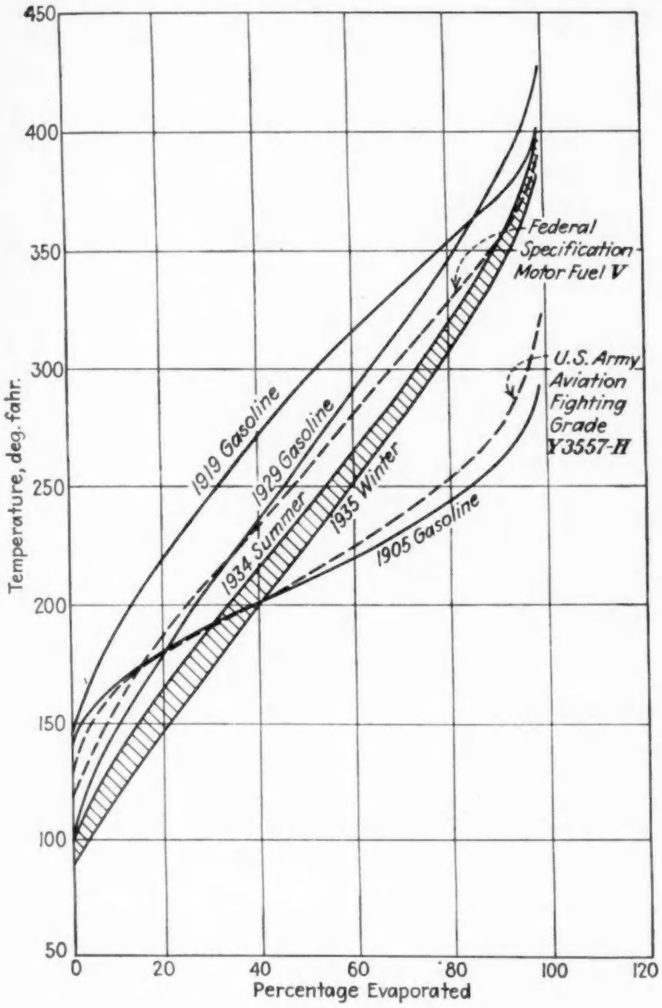


Fig. 2—Distillations of Characteristic Gasolines for the Period 1905 to 1935.

Table 1—Properties of Test Gasolines

Series 1

	1-*A*, Deg. Fahr.	2-*A*, Deg. Fahr.	3-*A*, Deg. Fahr.	4-*A*, Deg. Fahr.	5-*A*, Deg. Fahr.	6-*A*, Deg. Fahr.	7-*A*, Deg. Fahr.
Initial	136	120	96	90	98	104	104
10 per cent (Collected)	186	167	147	130	132	134	130
20	216	196	179	158	152	146	140
30	235	223	211	188	174	158	152
40	257	248	242	224	196	172	165
50	277	270	267	252	220	190	178
60	296	293	284	280	250	212	195
70	319	318	312	296	279	240	213
80	336	339	336	329	310	292	254
90	366	368	366	354	346	340	314
Maximum per cent (Collected)	409	412	409	395	389	390	379
Percentage Evaporated at 158 deg. fahr.	3.5	8.0	13.5	19.5	22.5	29.5	35.0
Temperature 90 per cent Evaporated, deg. fahr.	366	368	366	357	347	339	315
Loss, per cent	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residue, per cent	1.0	1.0	1.0	1.0	1.0	1.0	1.0
A. P. I. Gravity, deg.	56.0	57.9	59.6	61.3	63.5	65.1	68.5

Series 2

	1-*B*, Deg. Fahr.	2-*B*, Deg. Fahr.	3-*B*, Deg. Fahr.	4-*B*, Deg. Fahr.	5-*B*, Deg. Fahr.	6-*B*, Deg. Fahr.
Initial	94	94	98	92	114	116
10 per cent (Collected)	136	134	140	134	140	144
20	173	164	166	160	152	154
30	208	196	192	182	166	164
40	240	226	212	202	178	173
50	272	252	234	216	192	180
60	298	274	252	232	204	187
70	326	298	270	247	216	195
80	354	322	294	267	234	204
90	386	356	326	294	254	216
Maximum per cent (Collected)	423	398	378	354	300	256
Percentage Evaporated at 158 deg. fahr.	19.0	20.0	19.0	20.0	23.5	23.5
Temperature 90 per cent Evaporated, deg. fahr.	376	347	318	291	253	217
Loss, per cent	3.0	2.5	2.0	1.0	0.0	0.0
Residue, per cent	1.0	1.0	1.0	1.0	1.0	1.0
A. P. I. Gravity, deg.	60.9	61.5	62.9	65.4	68.4	69.3

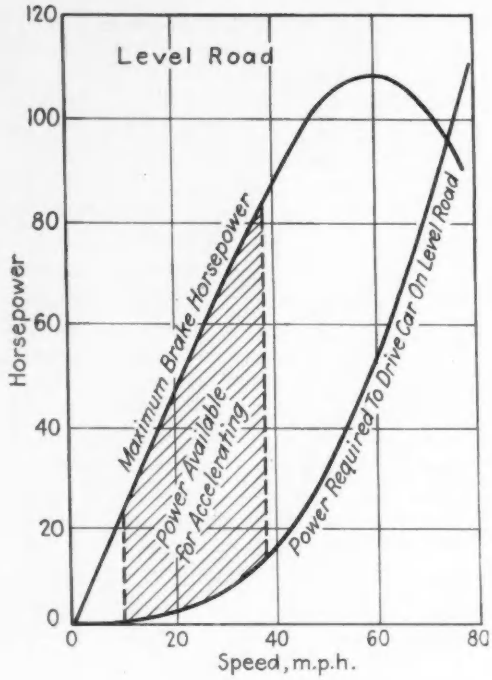
wet-bulb effect which may amount to 50 or 60 deg. fahr. and, therefore, may result in erratic and unreliable observations. Experience, based on observations of the temperatures of dry mixtures, indicates that under most conditions the true mixture temperature at the time it leaves the intake manifold is substantially the same as, or at least is directly related to, that of the manifold wall when measured at a point about 2 or 3 in. from the cylinder block.

(2) *Fuels Employed.*—To study the effects of both "front-end" and "total" volatility, two series of fuels were prepared. Sufficient quantities were provided to insure completion of the program without involving the necessity for duplication of any specific fuel. The A.S.T.M. characteristics of the gasolines are shown in Figs. 8 and 9, and Table 1. The fuels in Series 1 had substantially the same 90-per cent point, ranging from only 315 deg. fahr. to 368 deg. fahr.; whereas the amount evaporated at 158 deg. fahr. varied from 3.5 to 35.0 per cent. The fuels in Series 2 all had approximately 20-per cent evaporated at 158 deg. fahr., but their 90-per cent points ranged from 376 deg. fahr. to 217 deg. fahr.

The average gasoline sold in the Middle West during the summer of 1934 is typical of Fuel 4-*A*, which had 19.5 per cent evaporated at 158 deg. fahr. and a 90-per cent point of 357 deg. fahr. Aviation gasolines in general correspond to

Fig. 3—Actual Tests in which the Time Required To Accelerate from 10 to 38 M.P.H. Up the Uniform 5.5-Per cent Grade Shown Was Observed

The start of the test was at *A*; the start of acceleration, at *B*.



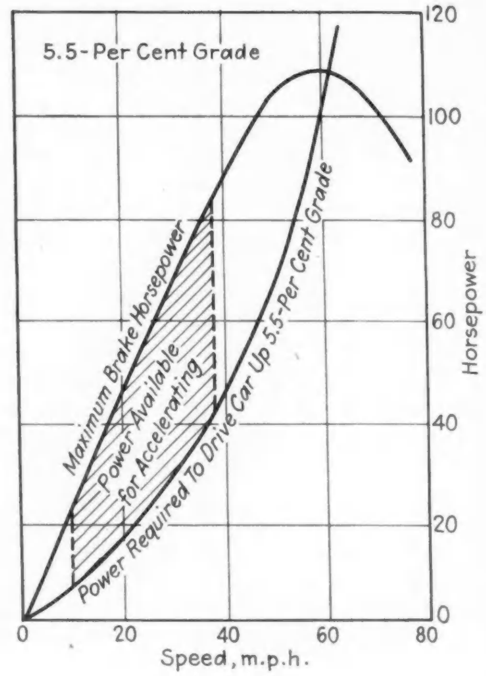


Fig. 4 (*Left*) and Fig. 5 (*Right*)—Power Available for Accelerating

Fuel 6-*B*. Of course, there may be some fuels that are slightly more or less volatile than these fuels in their respective classes. U. S. Motor Gasoline would be in the class with the least-volatile fuel used in this work, such as Fuel 1-*A*, since a gasoline with about 8-per cent evaporated at 158 deg. fahr. and a 90-per cent point of 392 deg. fahr. would meet the Federal specifications.

Experimental Results

There are numerous references to the improvement in horsepower output due to decreasing intake-air or mixture temperature. The work of Sparrow[3], which was done with aviation engines, shows that the indicated horsepower varies approximately inversely as the square root of the absolute temperature of the intake air. Theoretically, the air density varies inversely as the absolute temperature and, if it were not for other effects within the engine, the indicated horsepower should vary accordingly. Gagg and Farrar[4] have pointed out the inadvisability of using such relationships for brake horsepower which, nevertheless, some people have attempted to do.

Professor Roesch[5] has developed an equation based on laboratory engine-tests where the brake horsepower is shown to be inversely proportional to the 0.995 power of the absolute temperature of the intake manifold or, in other words, is very closely inversely proportional to the absolute temperature. The temperature referred to in Professor Roesch's work is that of the intake-manifold wall, the location of which corresponds very closely to that used in this investigation. The work of Sparrow, of course, refers to intake-air temperatures of aviation engines and it is believed that, for passenger cars, where different kinds and amounts of hot spots are used, it is much more desirable to use manifold-wall temperatures rather than intake air for the obvious reason that two engines may have entirely different amounts of hot spot and one would not expect the brake or indicated horsepower to follow

[3] See National Advisory Committee for Aeronautics Report No. 190; "Connecting Horsepower Measurements to a Standard Temperature", by Stanwood W. Sparrow.

[4] See S.A.E. JOURNAL, June, 1934, p. 217; "Altitude Performance of Aircraft Engines Equipped with Gear-Driven Superchargers", by R. F. Gagg and F. V. Farrar.

[5] See *Automotive Industries*, May 11, 1929, p. 732; "Temperature and Pressure Effects upon Engine-Power Development", by Prof. Daniel Roesch.

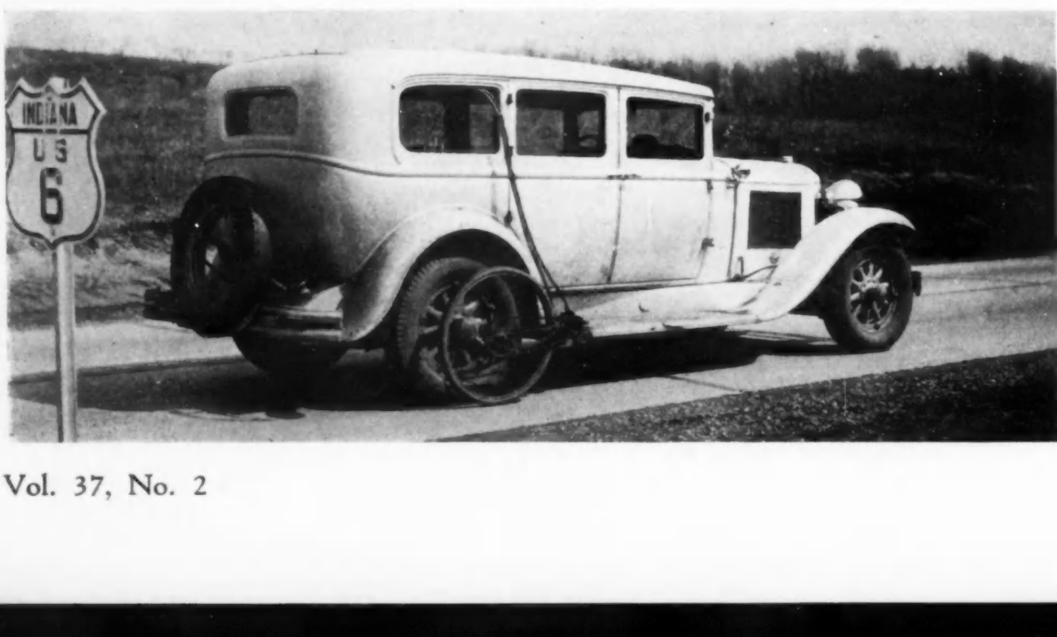


Fig. 6—Test Car Equipped with a Fifth-Wheel Speedometer

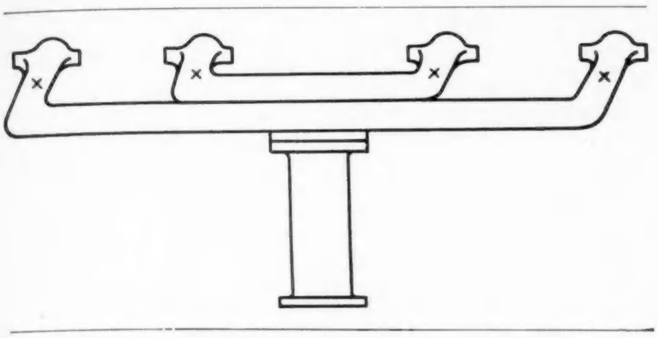


Fig. 7—Intake-Manifold Thermocouple-Locations
The locations are indicated by the marks X.

necessarily the intake-air temperature such as it probably does in the aviation engine.

Fig. 10 shows the results of a test in which the manifold-wall temperature was varied from about 55 deg. fahr. to 267 deg. fahr. It should be mentioned that the higher manifold temperatures are not exaggerations, since such temperatures do actually occur under normal driving-conditions in summer weather. At manifold temperatures below 150 deg. fahr., more-volatile fuels had to be used as will be explained later. The equation best fitted to this curve would indicate a very close relation to that of Professor Roesch where the brake horsepower is approximately inversely proportional to the absolute temperature. The consensus of the various investigators on this subject seems to indicate that, for every 10-deg. fahr. change that is made in manifold-wall or mixture temperature, there will be approximately a 2-per cent change in horsepower (in the range of normal passenger-car practice) available at the rear wheels.

The effects of volatility changes at several representative manifold temperatures are exemplified in Figs. 11, 12 and 13. The total number of tests made in the course of this work was quite large and extended over quite an appreciable length of time. The foregoing examples serve to illustrate, however, the manner in which the work was carried out. (It should be pointed out that fuels in Series 1 have been corrected to a 90-per cent point of 350 deg. fahr., and fuels in Series 2 have been corrected to 20-per cent evaporated at 158 deg. fahr., as the results of a preliminary analysis had indicated 1 per cent at 158 deg. fahr. was equivalent to approximately 5 deg. fahr. at the 90-per cent point). In every instance, operation of the engine was quite smooth and the loss in performance, such as represented by a 15-per cent increase in accelerating time, would not have been particularly noticeable to the lay observer. Under conditions of very poor distribution, engine operation, of course, became ragged.

It is obvious from an inspection of Figs. 11, 12 and 13 that, for each series of tests at a given manifold temperature, it is possible to secure the same change in engine performance by either of two methods, that is, by varying front-end volatility of the gasoline or by varying total volatility. Also, the best performance at any particular manifold temperature is the

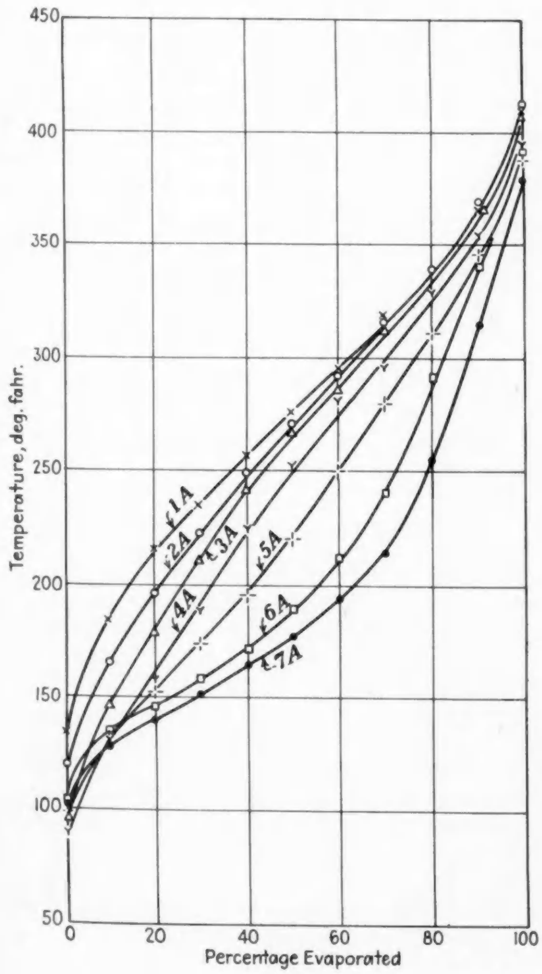
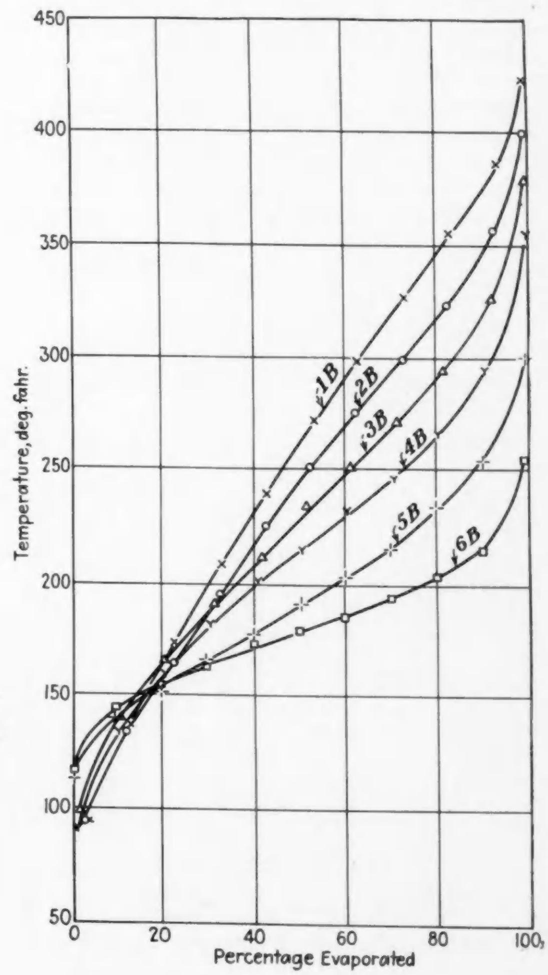


Fig. 8 (*Left*)—A.S.T.M. Distillations of Fuels in Series 1

Fig. 9 (*Right*)—A.S.T.M. Distillations of Fuels in Series 2



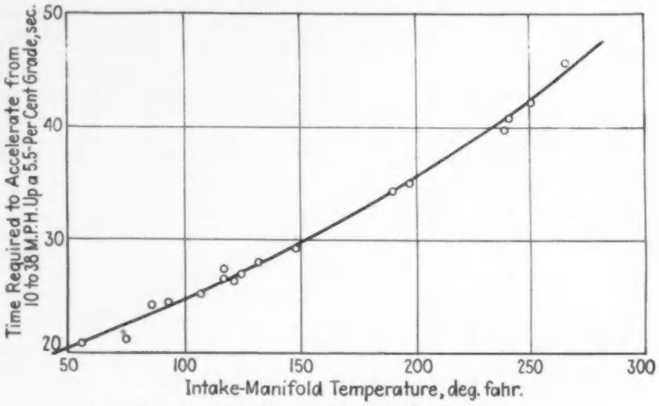


Fig. 10—The Effect of Intake-Manifold Temperature on Hill Climbing

The manifold wall-temperature was varied from about 55 deg. fahr. to 267 deg. fahr.

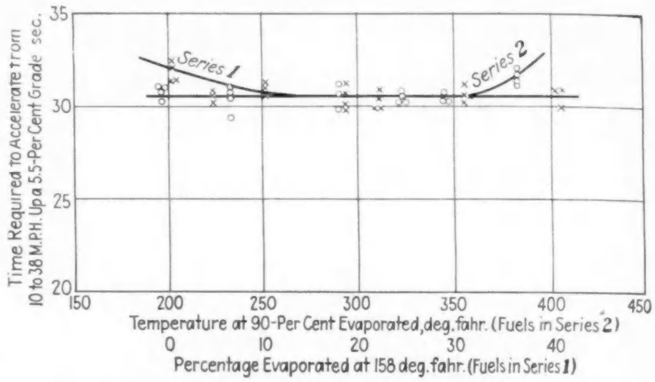


Fig. 11—Effect of Front-End and Total Volatility on Hill-Climbing Performance

The temperature of the intake manifold was 155 deg. fahr.

same, regardless of whether it is attained by providing the necessary "front-end" volatility only or by reducing the 90-per cent evaporated point. The same result may be achieved also, of course, by any intermediate combination of front-end and total volatilities. In general, it is felt that the data so obtained are satisfactorily consistent and that the curves so determined may be used as a reliable basis for determining the relation between "front-end" and "total" volatility insofar as they affect engine accelerating-performance at equilibrium operating-temperatures. These faired hill-climbing curves and others not shown have been used in preparing Fig. 14 which, together with Fig. 10, really summarize this work quite completely.

In preparing Fig. 14, a fuel having 20-per cent evaporated at 158 deg. fahr. and 90-per cent evaporated at 350 deg. fahr. has arbitrarily been chosen as a reference; and the effects of variations in fuel volatility, either front-end or total volatilities, are expressed in terms of the performance of this particular reference fuel. Curve *A* in Fig. 14 represents fuels of different volatilities and the relation between the amount which must be evaporated at 158 deg. fahr. to produce the same volatility effect on acceleration performance as a given change in the 90-per cent evaporated point. It then becomes possible to establish a curve for constant volatility and car performance, such as Line *B*. This indicates that the particular standard of engine output can be obtained with fuels having any combination of front-end and total volatilities corresponding to this curve. The practical limits to the variations so indicated would be set by starting requirements and dilution restrictions. By the same procedure, a higher standard of engine performance would be attained by the use of colder manifold temperatures which would require volatilities as indicated by Curve *C*.

These curves indicate the fallacy of going to extremes in any one feature to obtain some particular volatility effect, as a similar result may always be obtained by a judicious compromise without incurring the difficulties which must accompany attempts to provide either very excessive front-end volatilities or very low 90-per cent points. From such data it becomes readily possible to select the best volatility combination for any new performance requirement without incurring abnormal deviations from good practice in any one feature. It is hoped that this extension of the present work may be presented in the near future. As a matter of passing interest, Figs. 15 and 16 show respectively the front-end and total-volatility limits for different intake-manifold temperatures for the test car used, the requirements in amount off at 158 deg. fahr. being based on a 90-per cent point of 350 deg. fahr.; and those in Fig. 16 on the basis of 20-per cent evaporated at 158 deg. fahr.

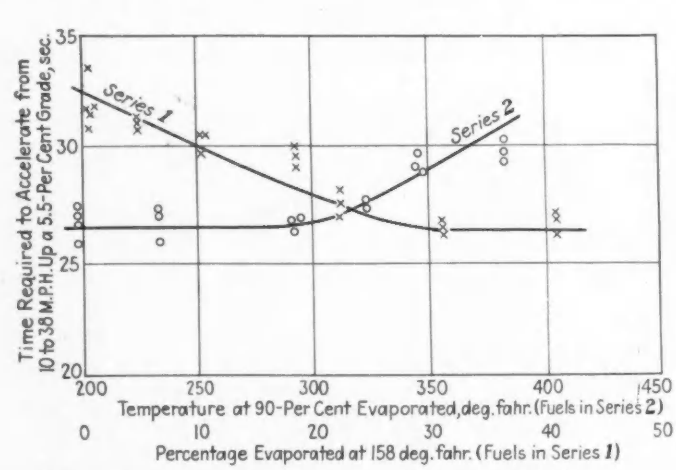


Fig. 12—Effect of Front-End and Total Volatility on Hill-Climbing Performance

The temperature of the intake manifold was 120 deg. fahr.

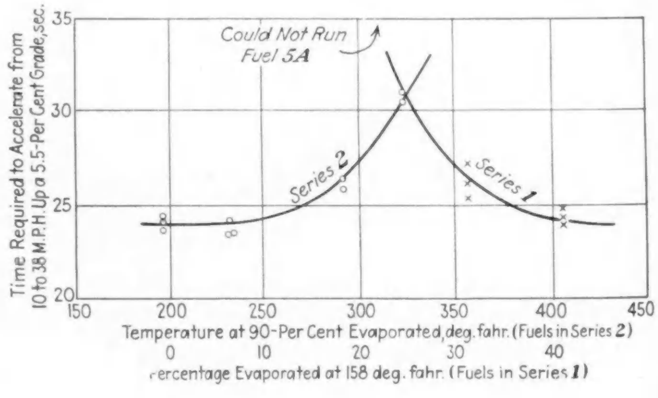


Fig. 13—Effect of Frond-End and Total Volatility on Hill-Climbing Performance

The temperature of the intake manifold was 90 deg. fahr.

Discussion and Conclusions

In discussing the foregoing results it should be kept in mind that, ordinarily, if reductions can be effected in mixture temperature, an increase in compression ratio may be permitted for any given octane number of motor gasolines. The effect of mixture temperature on knocking tendency is not a particularly definite relation; but, in the car used in this work, it appeared to be in the order of 1 octane number for each 15 or 20-deg. fahr. change. This would indicate that, where advantage is taken of these two effects, improved volumetric efficiency and the use of a higher compression ratio because of the lesser tendency to detonate with the colder mixtures, the brake horsepower may be increased about 15 to 20 per cent for a 60-deg. fahr. decrease in the intake manifold or mixture temperature.

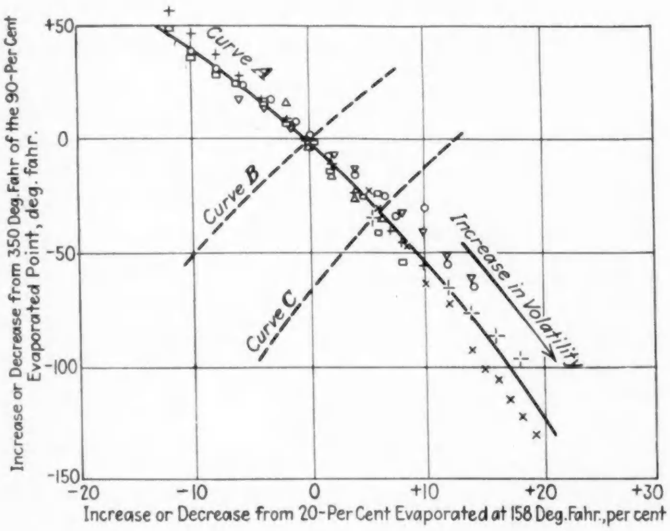


Fig. 14—Fuels Typical of Series 1 and Series 2 That Have Similar Volatilities

The fuels typical of Series 1 are represented by abscissas; the fuels typical of Series 2, by ordinates. For fuels typical of Series 1, the temperature of the 90-per cent point was constant at 350 deg. fahr. For fuels typical of Series 2, the percentage evaporated at 158 deg. fahr. was constant at 20 per cent.

If we choose to go half way and obtain a 7.5 to 10-per cent increase in horsepower, then the mixture temperature need only be lowered 30 deg. fahr. and the compression ratio increased about 0.25 of a ratio. The antiknock requirements of this altered engine will be substantially the same as that of the lower-compression-ratio engine with its hotter intake manifold. The improvement in fuel volatility required to give this improved performance would be that represented by the difference between the average summer and winter gasoline of today. If passenger cars could handle winter gasoline in summer, then there could be effected a 7.5 to 10-per cent increase in horsepower of present-day engines. In other words, the average winter gasoline in the Middle West is capable of developing about 7.5 to 10 per cent more power than summer gasoline if the engine design is changed to take full advantage of the properties of present winter gasoline. In any event the intake manifold should operate at about 30 deg. fahr. colder in the winter than it does in the summer so as to take advantage of the difference due to volatility.

It seems that considerably more attention should be directed toward preventing, during normal driving conditions, the extremely large fluctuations in the temperature of the

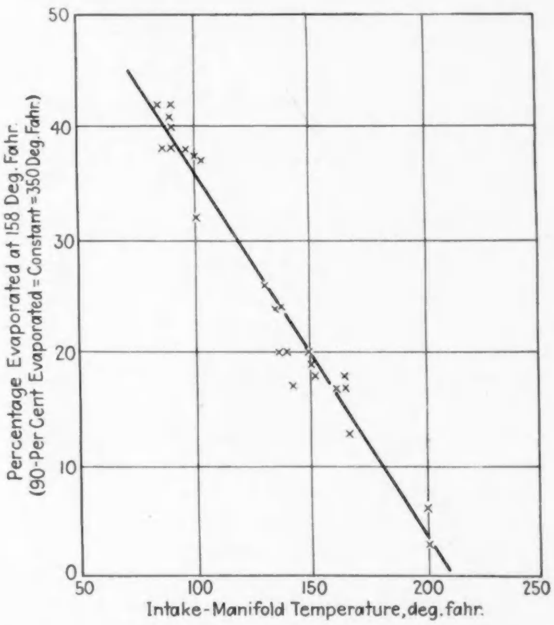


Fig. 15—Curve Showing the Minimum Front-End Volatility Required To Give Satisfactory Accelerating from 10 M.P.H.

intake manifold, particularly on the hot side. Most of us are familiar with the lack of "pep" in nearly all cars when attempting to accelerate again to a high speed after having come down to a relatively slow speed. In general, with present-day average-gasoline, the temperature of the intake manifold should never be required to operate at much above 160 deg. fahr. in the summer and about 130 deg. fahr. in the winter if the same low-speed requirements of car performance are set up as used in this investigation. It is realized that no two people will generally agree on this latter point; therefore, the more rigid the requirements are, the higher will be

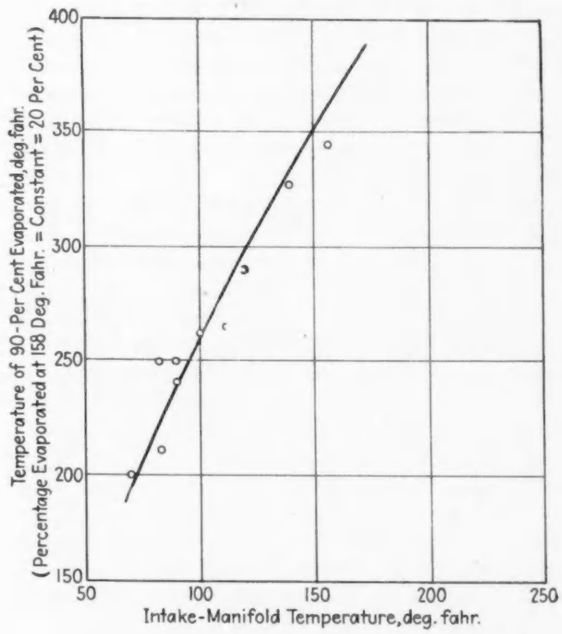


Fig. 16—Curve Showing the Maximum Total Volatility That Will Permit Satisfactory Acceleration from 10 M.P.H.

the temperature at which the intake manifold will have to operate.

The supposedly adverse effect of lower specific gravity or higher A.P.I. gravity of the more volatile fuels on gasoline mileage cannot be passed without some comment. The work by MacCoull[6] indicates that there may be some slight disadvantage under *constant speed* and *full throttle* if the carburetor is not adjusted for each change in gasoline volatility. If such gasolines are used in service with private cars, it is almost impossible to detect any such effect because of numerous other more important variables. Actually, some recent mileage tests of personal cars indicate that the lesser use of the choke during warming-up and the better acceleration in high gear—requiring less second-gear work—results in as good, and in some cars better, gasoline mileage with the more-volatile fuels, provided, of course, that volatility variations are kept properly balanced and are not permitted to go to extremes in either front-end or total volatility.

It will be noted from the foregoing that the general trend of the last four years toward improved volatility—from the manifold-distribution viewpoint—has resulted in making available fuels of definitely increased usefulness. The practice of seasonal adjustment, intelligently applied, is adding materially to this improvement trend. It is felt that truly "weather-wise" gasolines offer a very real opportunity for definite improvements in engine output.

Discussion

Additional Comments on Several Features

—Gilbert Way
Chrysler Corp.

DATA and curves given in this paper substantiate our opinion that extremes in front-end volatility are not necessary for improved warm-up operation due to this quality of the fuel.

Our test work also indicates that, with fuels of increased total volatility, satisfactory starting is obtained with automatic chokes calibrated for conventional-type winter-gasolines. These same calibrations may cause considerable difficulty with fuels of extreme front-end volatility.

Another difficulty encountered with fuels of this type is an unstable idle condition which results in constant stalling during the warm-up period. Increase in volatility above the 50-per cent point apparently does not give trouble in this respect.

The authors direct attention to the undesirability of large intake-manifold temperature-fluctuations. In this connection it might be pointed out that the wide temperature range in which an automobile engine is designed to give satisfactory operation demands the application of manifold heat under some conditions whereas, in hot-weather operation, a minimum of heat is desired. To design a single manifold to fulfil the above extremes imposes distinct limitations. A manifold supplying even insufficient heat for proper vaporization in cold weather might easily be an offender on the hot side under the condition of coming down to a low speed after high-speed operation. Here, the very fact that there is an interconnection between the manifolds, even though all exhaust gases are shut off, will result in a brief period of excess heat during the time of heat dissipation from the exhaust manifold. It is obvious that a major service-operation on the manifold each spring and fall to prepare the car for the ensuing season would be highly impractical.

In regard to relative gasoline mileage we have found that, with a fuel of rather extreme front-end volatility, economy in city operation is better directly after starting, the advantage diminishing so that mileage is equal at approximately seven miles, and is less thereafter. The type of operation, therefore, is a controlling factor in the relative fuel economy of conventional and highly volatile fuels.

[6] See S.A.E. JOURNAL, November, 1933, p. 363; "Effect of Gasoline Volatility on Engine Economy", by Neil MacCoull.

Status of a Transportation Executive

A RATHER general feeling exists, which no doubt is at least partly justified, that in many cases the higher company executive, either through ignorance of the subject or lack of time, is deficient in such genuine appreciation of the problems of his transportation executive as to give to him the time and attention, as well as the responsibility and authority, which are justified by the important and intricate nature of the transportation executive's job.

Like other human beings, a transportation executive can be classified as good, bad or indifferent. He is sometimes addicted to self-pity. Often, he possesses the well-known inferiority-complex. Still oftener, he lacks the self-energizing ability which is so important if he is to solve the many difficulties under which he labors. Sometimes he lacks the initiative and the personality, as well as the broad perspective of his job, which he needs to "sell" its importance and *his* importance to his chief executive.

On the other hand, we find in the great majority of motor-transportation executives men of sincere purpose, of long experience in the business, desiring only that recognition of the importance of their position should come from a realization of the operating results which they achieve.

The close attention by higher company executives to their automotive departments, which is so obviously demanded, is, unfortunately, not always to be found. Seemingly, the technical intricacies of scientifically applying motor-transport equipment to haulage problems are, to some, simply something to brush aside impatiently.

It is of extreme importance that the higher company executive arbitrarily allocate enough of his personal time to digest and learn thoroughly just what his motor-transport problems are.

The company executive, if he will but spend the right amount of time intelligently on this complex problem, cannot help but gain the complete understanding which is necessary if he is to reap the benefits of economies which can be achieved only as a result of his final authority.

If the company executive will *insist* upon a cost system which will tell him the facts, if he will appreciate the technical and business qualifications necessary to the proper fulfilment of the transportation-executive's job, then surely he will be more inclined to dignify that job with authority as well as responsibility, and with the recognition and the compensation which are demanded if real transportation economies are to accrue.

Excerpt from a Metropolitan Section paper on "Principles of Fleet Operation," by T. L. Preble, supervisor of automotive equipment, Tide Water Oil Co.

An Automatic Power and Mixture Control for Aircraft Engines

By Guy E. Beardsley, Jr.
Project Engineer, Pratt & Whitney Aircraft Co.

THE basic idea of accomplishing both a power limitation and a control of the mixture with one unit was evolved by the late Thorp Hiscock. He proposed, by throttling the air entering the carburetor, to maintain the density of air entering the venturis equivalent to that at an altitude of 7000 ft. Thus the carburetor would virtually be held at 7000 ft. and would deliver, even though the airplane might be at sea level, a mixture of the same fuel-air ratio that it would normally deliver at 7000 ft.

Details of the development of the automatic power and mixture-control unit are given, together with descriptions of tests made and statements of results obtained.

In conclusion, it is stated that, from the reports available on general fuel consumptions, it is apparent that some method of control is desirable. Further, that it is also highly desirable from a standpoint of engine reliability and durability that a means of controlling the horsepower output of supercharged engines as well as the fuel consumption be provided. The device described provides both these features, with certain limitations.

THE importance of regulated fuel consumption is becoming more and more evident with the advent of high-powered engines and long-range airplanes. Where formerly adjustment of the mixture control could be left to the discretion of the pilot, we have now reached a stage of development where the uncertainty of this method becomes a serious handicap. It is a well known fact that variations in fuel consumption of as high as 25 per cent are obtained on the same airplane when operated by different pilots. Some of this difference undoubtedly lies in the relative amount of power used; but, on occasions, it has been found that similar airplanes operating simultaneously over the same scheduled route have shown a variation of 10 per cent in their hourly consumption.

Because of the high performance demanded from modern aircraft engines, we have reached a point in their development where excessive leaning-out by use of the mixture control becomes a dangerous procedure. This means that the pilot must be instructed how to set his mixture properly. To this end a series of tests was run where the pilot set the mixture control in accordance with a method based on the variations in the speed of an engine turning a fixed-pitch propeller. Level flight was maintained at various altitudes and the mixture set for a prearranged change in engine speed. Not only was there an 8-per cent variation, depending on altitude, but it was found that re-checks at the same altitude by richening-up and resetting the mixture control gave variations of over 5 per cent. This is perhaps the best known and most widely used method of mixture adjustment. With the advent of the constant-speed propeller it is obvious that it must be abandoned unless a provision is made whereby the propeller can be locked at one pitch-setting to permit mixture adjustment.

Furthermore, now that so many of the current models of aircraft engines are of the supercharged type with which full-throttle operation is not permitted below a specified altitude, it is important that some method of limiting this power be used. Supercharger pressure-gages are used extensively but require the constant attention of the pilot, already overburdened with a multiplicity of duties, if maximum allowable power is to be obtained at all altitudes. Throttle stops or gates severely limit the power at altitudes below the critical altitude where full-throttle operation is permissible. Automatic supercharger-regulators or boost controls give an ideal regulation of engine power-output. With any of the foregoing arrangements a means is provided to override the power limitation and sufficient fuel feed from the carburetor must be provided to insure no resulting damage to the engine if the pilot accidentally or of necessity exceeds the limitation.

Let us consider the normal action of a carburetor as shown

[This paper was presented at the Regional Meeting of the Society, Hartford, Conn., April 26, 1935.]

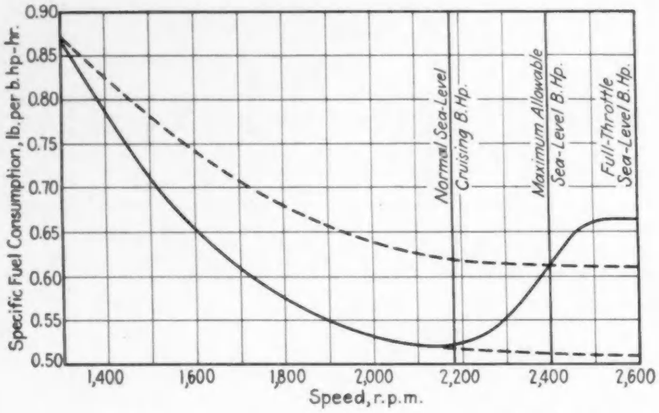


Fig. 1—Curves Illustrating the Normal Action of a Carburetor

The solid-line curve shows the shape of the specific-consumption to insure reliable engine-operation; at maximum power, the fuel curve would be similar to the upper dotted-line curve.

graphically in Fig. 1. As the throttle is opened and more power is available from the engine, the mixture delivered by the carburetor should be rich enough to insure smooth reliable engine-operation. This necessitates the shape of the specific-consumption curve shown by the solid line. From the lowest speeds where the main metering system is in operation up to the low point on the curve, the carburetor is delivering virtually a constant fuel-air ratio, the downward slope to the curve being caused by increasing mechanical efficiency of the engine. Above the lowest point (2180 r.p.m.) it is considered desirable for reliable engine-operation gradually to increase the specific consumption. This is usually accomplished by a mechanically operated needle valve, bringing an auxiliary jet into operation. For sea-level-rated engines the curve would stop at the line marked "maximum allowable sea-level power"; but, in the case of an altitude-rated engine, it would continue on up as shown.

Due to the inherent metering characteristics of a venturi-type carburetor the fuel-air ratio increases with decreases in density of the air entering the venturi. For this reason the whole curve moves upward as the airplane ascends. To correct for this properly, a device sensitive to changes in fuel-air ratio should be used and such a device would also have to compensate for changes in air flow, as it is not necessary to have the enrichment shown from 2180 r.p.m. to full throttle above an altitude where the full-throttle power does not exceed the value obtained at 2180 r.p.m. at sea level. At present there are available devices for measuring fuel-air ratio, such as they are; but, generally speaking, they are too cumbersome to be usable.

As any automatic device must have a definite medium to act upon, the air density seems to be the most auspicious one. By automatically controlling needle valves in the carburetor in response to changes in air density entering the venturis, a solution would theoretically be possible. Practical application, however, has shown that fuel metering by means of positioning needle-valves is not extremely accurate in view of the tremendous change in orifice coefficient with small changes in needle position. In this respect it is pointed out that, even though the needle may be held at a definite height in the orifice, a change in orifice coefficient occurs if the needle is moved from a concentric position to an eccentric one.

Relatively low-velocity air, as used in conventional back-suction mixture-controls, is easier to regulate accurately with a needle valve than gasoline flow, but the application of a single automatically controlled back-suction valve merely produces a fuel curve as shown in Fig. 1 at all altitudes, and at full throttle at high altitudes gives a richer mixture than the power output warrants. This condition is exaggerated in the case of an engine having a high altitude-rating where provision has been made in the basic fuel curve for possible overriding of any of the already mentioned methods of power limitation.

It has been pointed out that changes in air density entering the venturis cause the changes in carburetor metering with changes in altitude. If, therefore, we were to maintain a constant density entering the carburetor venturis, we should have a carburetor delivering a mixture corresponding to the solid-line curve in Fig. 1.

It was with a knowledge of these facts that the late Thorp Hiscock evolved the basic idea of accomplishing both a power limitation and a control of the mixture with one unit. He proposed, by throttling the air entering the carburetor, to maintain the density of the air entering the venturis equivalent to that at an altitude of say 7000 ft. Thus the carburetor would virtually be held at 7000 ft. and would deliver, even though the airplane might be at sea level, a mixture of the same fuel-air ratio that it would normally deliver at 7000 ft. Fig. 2 shows diagrammatically the method by which temperature and pressure regulators can be employed to maintain a constant air-density. Density being a direct function of pressure and temperature, if both these qualities are held at constant values, a constant density results. Having thus assured

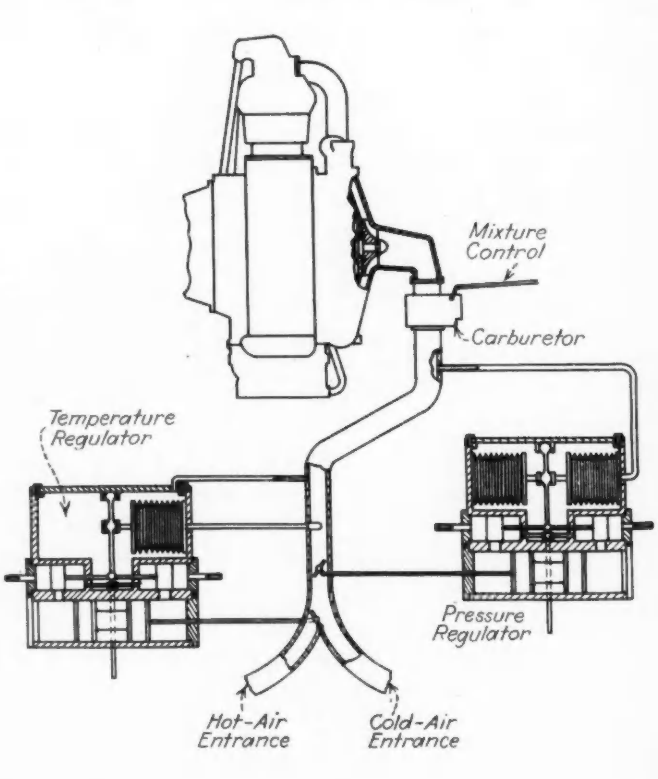


Fig. 2—Method by Which Temperature and Pressure Regulators Can Be Employed To Maintain a Constant Air-Density

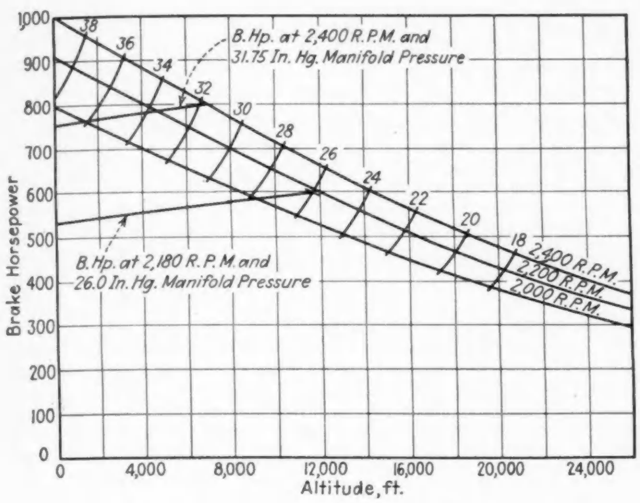


Fig. 3—Typical Power-Curves Showing the Normal Variation with Altitude

the maintenance of constant density below the altitude of 7000 ft. and thus holding constant the factors contributing to changes in carburetor metering, Mr. Hiscock further proposed to position the mixture control so that with a conventional carburetor a uniformity of fuel consumption would be maintained below this altitude. Inasmuch as throttling of an engine can be done at any point in the induction system, the standard carburetor throttle could be left open at all times and both the power and the mixture automatically controlled.

With the density of the air entering the carburetor at a constant value and the carburetor throttling-valves wide open, the density of the mixture entering the supercharger will remain virtually constant. This being true, then, as long as the impeller is turning at a constant speed, the manifold pressure will remain virtually constant. With this in mind, let us turn to the effects of such regulation on engine power-output.

Fig. 3 is a typical power-curve showing the normal variation with altitude. The curves sloping downward from left to right are full-throttle constant-speed points. Assuming this engine to have a rating of 800 hp. at 2400 r.p.m., it is seen that the critical altitude for this rating is 7000 ft. Below this altitude, full-throttle operation is not permitted. If, therefore, the absolute pressure entering the carburetor is regulated never to exceed the equivalent of this altitude, the power can never exceed the maximum allowable value. Due to the effect of exhaust back-pressure, the power output of the engine will decrease slightly at altitudes below the critical point. The line drawn from the critical-altitude point slightly downward and to the left to sea level shows this decrease, it being a line of constant speed and manifold pressure.

In most instances, powers ranging from 60 to 75 per cent of the engine rating are used for normal cruising operation. Considering 75 per cent or 600 b.hp. as a maximum, a similar limitation of power can be made by using a regulator set to maintain a pressure equivalent to the critical altitude for this condition. Considering 2180 r.p.m., a desirable engine speed for cruising, it is found by again referring to Fig. 3 that the critical altitude for this condition is 11,700 ft. Normally, a pressure regulator is fixed to maintain only one pressure; but it is easily seen here that it would be desirable to have a double range of pressures available.

At the time this work was started, some two and a half years ago, the most suitable type of pressure regulator available was the Eclipse Model-M 2641 supercharger pressure-regulator. It was found during early development work that, due to the method employed to actuate the servo piston in this unit, deviations exceeding 1 in. of mercury existed, depending on the position of the servo piston. The use of this regulator would have meant approximately a 5-per cent power-variation and 3-per cent fuel-consumption variation, assuming everything else perfect. Being unwilling to accept such inherent variations, the first step was to develop a more suitable pressure regulator. In doing so the additional feature of a double range was included.

Various means for positioning the carburetor mixture-control valve were tried both with back-suction type and needle-type controls. In neither case were the results consistent enough to warrant further development work along these lines. The needle type again proved itself incapable of consistent and repeated results, and the back-suction type was equally poor due to vapor lock. In this type of control, as the mixture is leaned-out the area provided for float-chamber venting usually decreases until, in the full-lean position, only the area of a No. 50 drill remains. With the absolute pressure in the float chamber reduced to the equivalent of 10,000 or 11,000 ft., some vaporization of the gasoline takes place in the float chamber and, unless adequate vent-area is provided to relieve this, the differential head between float chamber and discharge nozzle will be affected, thus changing the metering characteristics of the carburetor.

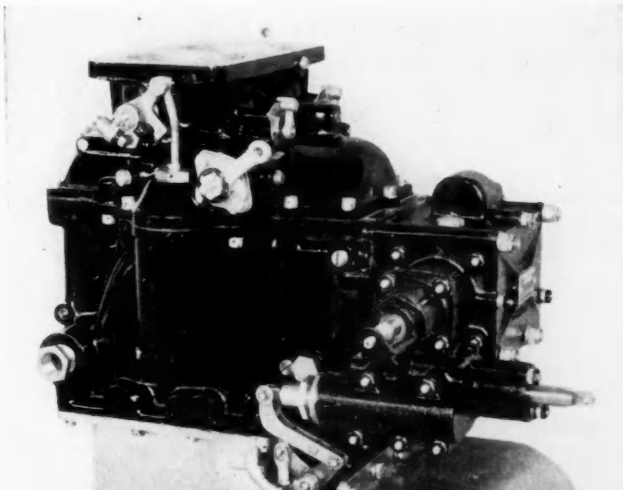


Fig. 4—Stromberg Model NA-Y9C Carburetor with an Eclipse Model 3105B Regulator Mounted on the Rear

During all the attempts at positioning the mixture-control valve, it was realized that the general shape of the fuel curve of Fig. 1 would be maintained. As already pointed out, the enrichment from 2180 r.p.m. on to full throttle is only necessary due to the increased power. If the full-throttle power does not exceed that obtained at 2180 r.p.m. at sea level, there is no need for the enrichment and a curve like the lower dotted line would be more desirable. As is evident from Fig. 3, if the pressure in the carburetor is restricted to the equivalent of that at 11,700 ft., this power can never be exceeded. If, therefore, instead of the usual economizer action a system of poppet valves controlling jets were to be used, the enrichment could be eliminated when the power limitation so warranted. Of course, sufficient jet capacity must still be provided when maximum allowable power is available. Thus, at maximum power, the fuel curve would be similar to the upper dotted line in Fig. 1. With such an arrangement, excess fuel is provided if operating at part throttle with a 7000-ft. power-limitation, but this can be avoided by shifting the setting of the device to 11,700 ft. and using full throttle.

With this brief history in mind, let us consider the present production apparatus. Fig. 4 shows the Stromberg Model NA-Y9C carburetor with an Eclipse Model 3105B regulator mounted on the rear. Shown here is an elbow air-scoop below the carburetor with the air-valve assembly in place. The operating linkage between the regulator and the air-valve assembly is clearly visible. Perhaps some will wonder why the air valves are not made integral with the carburetor. It was and still is intended to do so; but, with the present type of carburetor construction, excessive variations in metering were experienced with the valves so located. To provide a unit adaptable for immediate service use, the method shown here of spacing the air valve at some distance from the carburetor was adopted.

Fig. 5 shows diagrammatically the operation of the automatic mixture-control regulator. It will be seen here that the principal operating parts of the regulator consist of two bellows, a lever arm actuated by any movement of the bellows, and a needle valve directing oil to the two sides of the operating piston. Of the two bellows, one is evacuated and spring loaded internally and the other vented behind the venturis in the carburetor, thereby being affected by the average carburetor air-horn pressure. If the absolute pressure in the air horn is such that the evacuated bellows is collapsed, the lever arm is drawn to that side and, being fixed at the top, draws the needle valve to that side. This action admits engine oil pressure to the back side of the operating piston at the same time opening the opposite end to drain, all of which forces the operating piston outward and, through suitable linkages, closes-off the pressure-control valves in the carburetor. As these valves are closing, the absolute pressure in the air horn is being reduced. When this pressure reaches a value such that the open bellows tends to collapse, thus expanding the evacuated bellows, the needle valve is thereby moved. During this movement there comes a time when the needle valve is in its central position, thus holding the operating piston and air valves stationary.

It will be seen that this set up is a vicious circle and, unless some method of damping is provided, mechanical hunting should be present. The necessary damping is provided by the taper on the needle valve. Tests were made to determine the extent to which the regulator would overshoot the mark, and a taper provided which would slow down the action near the balance point to reduce the overshoot slightly. The net result was to reduce the speed of action only when within 0.5 in. of mercury of the balance pressure.

The absolute pressure to which the unit regulates depends on the strength of the springs in the evacuated and open bellows. In this respect it is easily seen that an increase in spring compression in the open bellows will change the absolute pressure for balance to a lower value. This feature is used to enable the same regulator to control to two different pressures and is accomplished by what is termed the range-shifter piston, operating on the spring in the open bellows. Adjustable stop-nuts are provided to limit the travel of the range-shifter piston in both directions, thus providing an adjustment for both regulated pressures.

Fig. 6 shows diagrammatically the jet and passage arrange-

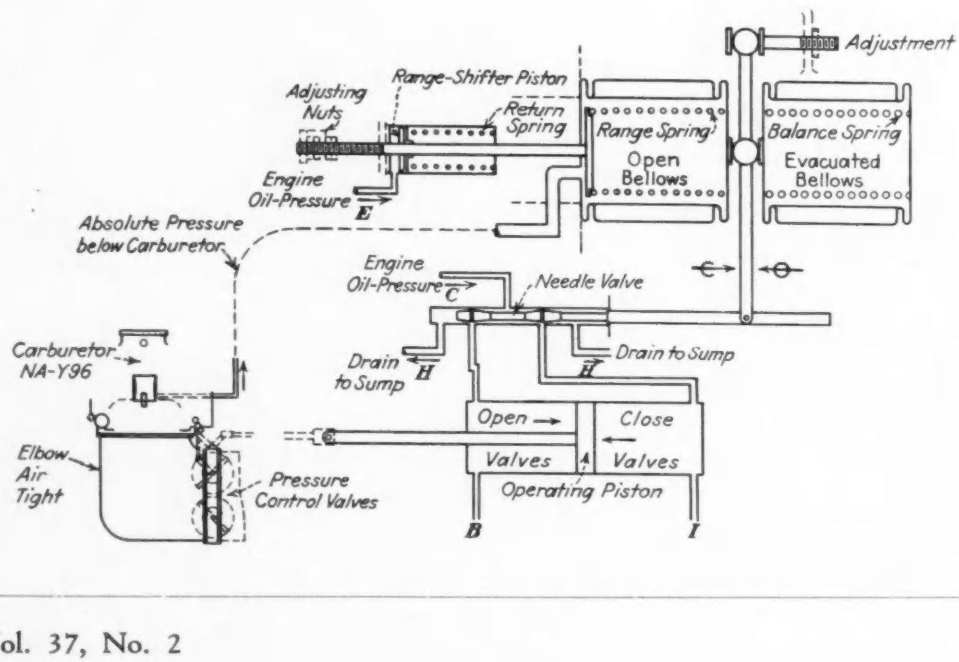


Fig. 5—Operating Diagram of the Automatic Mixture-Control Regulator

ment in the carburetor. The two outside passages are directly connected to the float chamber providing the fuel feed to the jets. The two cruising jets *I* and *M* are directly in these outside passages, and the two auxiliary jets are located in a by-pass passage arrangement around jets *I* and *M*. The auxiliary jets *G* and *L* are cut in or out of action depending on the position of the poppet valves marked *C*. After passing through the jets, the fuel goes across the lower passages to the center and up the central passage to the main discharge nozzles. For simplicity in explanation, let us consider the cruising position first. Here the regulator is maintaining a pressure equivalent to an altitude of say 11,000 ft. This means that the density in the carburetor is greatly reduced and that on a normal carburetor would require the use of some mixture control. In this carburetor jets *I* and *M* are selected to give the desired consumption at this altitude, the other two, *G* and *L*, being cut off due to the poppet valves *C* being closed. As the regulator will maintain a constant pressure in the carburetor, these two jets will give uniform metering at any altitude below that for which the device is set.

In the take-off or maximum-allowable-power position (sometimes used as a high-power cruising-position) the regulator is maintaining a pressure equivalent to a somewhat lower altitude, say 7000 ft. This necessitates additional jet capacity in the carburetor due both to the decrease in altitude and to higher power being available from the engine. To accomplish this, jet *G* is brought into action by relieving the oil pressure holding the poppet valve on its seat, thus allowing the spring to open this valve.

In addition to the two regulated positions, an emergency position is provided where the regulator is inoperative and atmosphere air has free entrance to the venturis. Under this condition a further increase in jet capacity is obviously required. This is accomplished by bringing jet *L* into action by relieving the oil pressure holding the poppet valve controlling this jet on its seat. By the proper selection of the various jet sizes, it is possible to obtain any desired fuel consumptions for the three possible operating conditions.

Fig. 7 shows the passages leading to and from the selector valve and the method in which the selector valve interconnects them. In the emergency position oil pressure is applied only to passage *B*, which is directly connected to the opening side of the operating piston. All other pressure passages are blocked-off. Similarly, in this position all drainage passages are open except the drain from the needle valve. By applying pressure to one side of the operating piston and opening the other side to drain, positive opening of the pressure-control valves is assured. The two jet-operating pistons are both open to drain and, being spring loaded, the needle valves are thus open, giving maximum fuel capacity in the carburetor.

In the take-off position, the two direct connections to the operating piston are closed-off and the pressure and drain connections to the needle valve are opened, thus putting the regulator into operation. Passage *E* to the range-shifter piston is still open to drain, so the pressure maintained will be the higher absolute figure corresponding to the lower altitude. Only one of the jets has been cut off to compensate for the first altitude condition.

In the cruising position, the only change from take-off is to shift the range spring so that regulation to a higher altitude is obtained and, at the same time, to cut out the second needle-controlled jet, thus giving the proper carburetor metering for the regulated altitude. This is accomplished by connecting

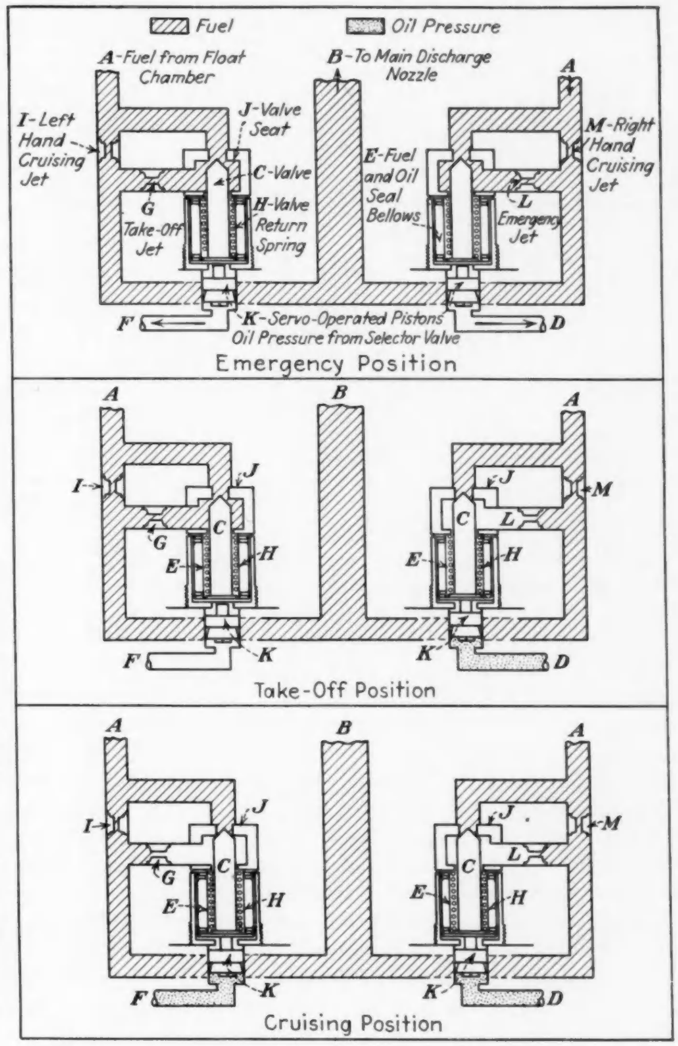


Fig. 6—The Jet and Passage Arrangement in the Automatic Mixture-Control Carburetor NA-Y9C

passages *E* and *F* to pressure instead of to drain. We are thus provided with a means of holding the power output in accordance with the values chosen in Fig. 3. At the same time there is a definite jet arrangement in the carburetor for each setting of the regulator, thus allowing an accurate means of mixture-strength determination.

During flight-test work with a power-and-mixture-control unit set to a critical altitude of 7200 ft., a test was made to determine at what altitude use of the manual mixture would be required. With the control delivering a lean best-power mixture when below the critical altitude, full-rich operation was checked at several altitudes and not until 15,000 ft. was reached was it found possible to note even a tendency for the engine to increase in number of revolutions per minute when leaning-out. Theoretical calculations based on these figures indicate that, with a critical altitude of 11,000 ft., best-power operation should be experienced without manual mixture-adjustment to approximately 20,000-ft. altitude. In view of full-throttle power decreasing at a greater rate than the fuel-air ratio increases with altitude, the hourly consumptions experienced when flying above the critical altitude of the control will decrease with increases in altitude.

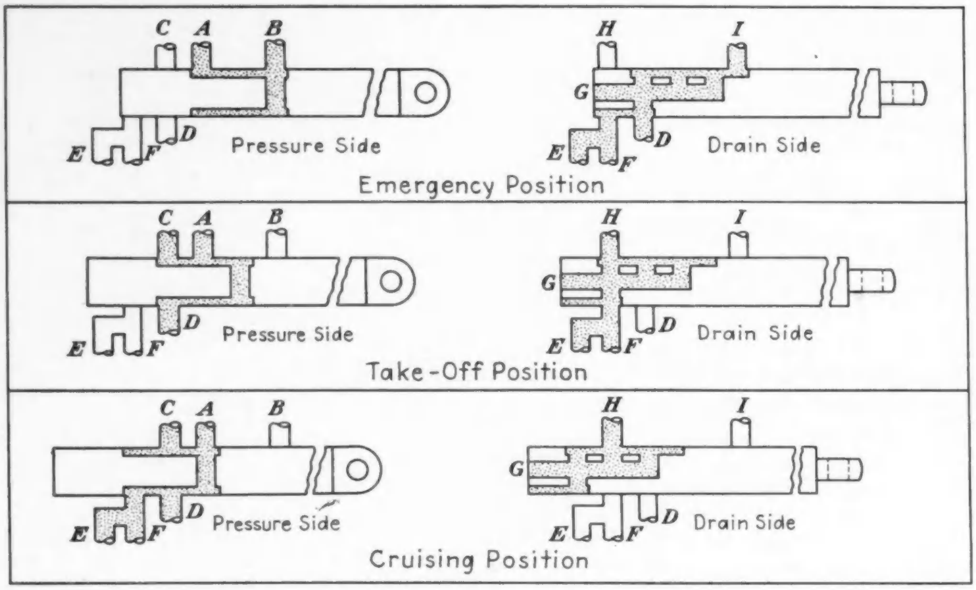


Fig. 7—Selector-Valve Operation

A represents engine oil-pressure; *B*, direct pressure to the opening side of the operating piston; *C*, pressure to the needle valve; *D*, the emergency carburetor jet; *E*, the range-shifter piston; *F*, the take-off carburetor jet; *G*, the drain to the sump; *H*, the drain from the needle valve; and *I*, the direct drain from the closing side of the operating piston.

Referring again to Fig. 3, we see the power control obtainable when this device is used on an engine having a constant-speed propeller. If, on the other hand, a two-position or fixed-pitch propeller were to be used, results similar to those shown in Fig. 8 might be expected. Here, because of the rapid change in engine speed with changes in altitude, a greater power-variation is experienced. It would probably be desirable to provide two cruising positions as shown here by the dotted lines. Even though this would destroy the advantage of power control at take-off, it would provide a more useful arrangement for general operation.

No provision has been made in this device for air-temperature regulation. This decision was made after talking with several operating companies who seemed to prefer to have the preheaters adjustable by the pilot in the event of possible ice formation.

Conclusions

From the reports available on general fuel consumptions, it is apparent that some method of control is desirable. It is also highly desirable from a standpoint of engine reliability and durability that a means of controlling the horsepower output of supercharged engines as well as the fuel consumption be provided. The device herein described provides both these features with certain limitations. The following conclusions give, in general, the salient features and do not attempt to delve into minute detail.

As a Mixture Control.—(1) Maintaining a constant density of the air entering the carburetor produces a practically constant fuel-air ratio delivered by the carburetor through the normal operating range.

(2) Above the critical altitude of the regulating device, enrichening with increases in altitude similar to normal carburetion will be experienced. Within the altitude range used for normal commercial operation, the enrichment above the critical altitude will not exceed the best-power mixture-strength. Inasmuch as operation above the critical altitude of necessity entails a reduction of the full-throttle horsepower, the hourly fuel consumption will decrease.

(3) For military work or other work requiring ascent to altitudes higher than in (2), a manual mixture-control should be provided.

(4) A more desirable shape of fuel curve is obtained at critical altitude than with a self-compensating mixture-control applied to a standard carburetor in that the same fuel-air ratio is delivered whether at part throttle or full throttle.

As a Power Control.—(1) With a constant-speed propeller, power regulation equivalent to any device maintaining constant manifold pressure is obtained. Such regulation is more satisfactory than that obtained with a throttle stop or gate.

(2) With a two-position or fixed-pitch propeller, power regulation slightly inferior to that available with constant manifold pressure is obtained due to changes in manifold pressure with changes in number of revolutions per minute. The result obtained, however, is still superior to that available with a throttle stop.

(3) For commercial or military operation where an extended cruising range with limited maneuverability is desired, this device offers an excellent solution.

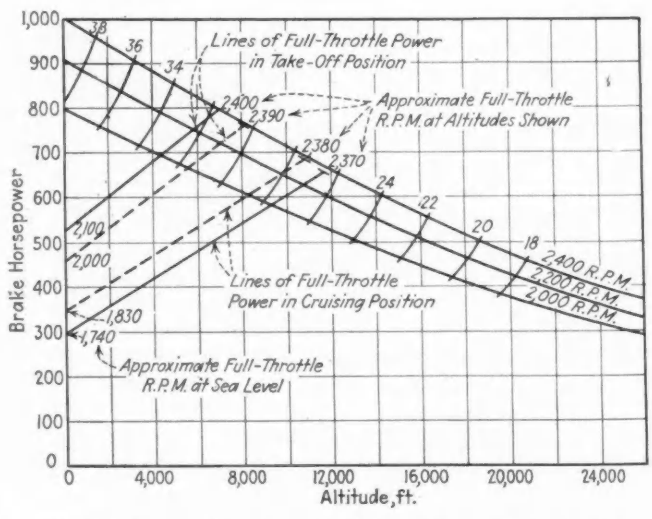


Fig. 8—Curves Showing the Power Control Obtainable when a Two-Position or Fixed-Pitch Propeller Is Used

The Trends in Engine Design as Influenced by Fuel Volatility

By John M. Campbell, Wheeler G. Lovell and T. A. Boyd

Research Division, General Motors Corp.

SINCE the design of the automobile engine depends largely upon the volatility and knock rating of the gasoline fuel it uses, a major problem is the fitting of the engine to these two fuel-characteristics.

Regarding volatility, the engine must take the best advantage of the present available fuels; its design cannot be entirely made to suit an *average* gasoline; and, once an engine has been built, it must operate and give satisfactory service over a considerable period of years.

Recent trends in important items of design are noted, as well as the trends to automatic chokes and warm-up controls.

The author states that a system of classifying gasolines in terms of volatility is needed, and discusses various aspects of the starting problem. Other features include comments upon the trends in mixture temperatures, acceleration, crankcase dilution, and vapor lock.

The conclusion reached is that changes will continue to be made in fuels and in cars; hence, there is need for fitting fuels to engines and engines to fuels to the best advantage of the user, especially because the automobile manufacturer and the gasoline producer are trying to please the same people.

THE utility of the automobile depends upon the fact that it converts the energy of gasoline into motion. The design of the automobile engine thus depends upon certain properties of the gasoline to be converted, and the two most important of these properties are volatility and knock rating.

One of the chief problems of engine design consequently consists in fitting the engine to these two fuel-characteristics in the most satisfactory manner. Combustion chambers, compression pressures, bearing pressures, ignition systems, cooling systems, and even weight per horsepower and miles per gallon, are determined to a large extent by the knock rating of the fuel. Fuel-supply systems, carburetors and manifolds, and starting equipment, are intimately related to the volatility of the fuel. If the fuel changes significantly either in respect to volatility or knock rating, there must then be a corresponding change in the engine to maintain the most satisfactory relationship between fuel and engine. This interdependence of the engine and the fuel available at the time when it is designed and built and the fuel available during its life makes it highly desirable that, so far as possible, the producer of the fuel and the builder of the engine work together on these problems of mutual interest.

Significant Factors in Fitting Engines and Fuels.—Concerning the problem of engine design as related to fuel volatility from the practical viewpoint of the engine builder, there are perhaps three factors that merit careful consideration. First, as mentioned before, the engine must be designed to take the best advantage of the present available fuels so far as practicable. Second, this design cannot be entirely made to suit an *average* gasoline, because there is no average gasoline, except as a statistical concept that is written down by the statistician; and so the automobile owner cannot purchase such a fuel. The driver buys one brand or another, or maybe he buys a large number of brands and in different parts of the country. The engine builder cannot tell the customer to buy any particular brand; and, since fuels are not commonly designated by volatility, the engine builder must therefore make an engine which will operate satisfactorily on almost any commercial gasoline. Obviously, in this situation the engine manufacturer cannot take full advantage of the potential value of the better ones of the fuels because he must also utilize some of those which would be considered as the worst from his standpoint. In the present state, these facts constitute a serious limitation upon the engine builder's freedom of action in this regard.

The third consideration centers around the fact that, once an engine has been built, it must operate and give satisfactory service over a considerable period of years. A car built today should give satisfactory service on a gasoline which is now underground and is going to be produced some years hence. And so some thought must be given to what the future gasoline is going to be. Even though it may be a great deal better

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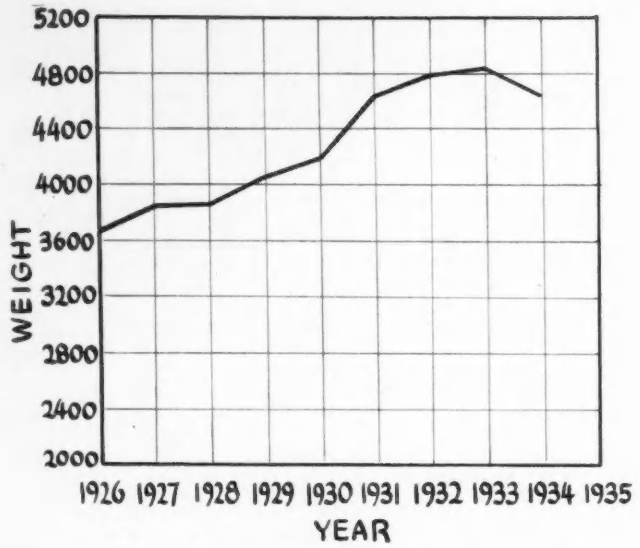


Fig. 1—Average Weight of Cars; 1926 to 1934

from the engine-builder's viewpoint, he may not be able to utilize these potential advantages, because at the moment he is limited by the fuels available at present. Similar considerations are of importance if future fuels are not going to be as good as present ones.

It is obvious that, because all of these considerations must be grouped together in formulating actual automobile design, a very considerable amount of compromise and guess is going to be involved. The compromises arise partly because gasolines are not uniform at a given time or over a period of time, nor are they at present even classified and adequately surveyed. The compromises arise partly also because a given model of car is quite a uniform product and lasts over a period of years. The guess is involved because no one knows what changes the future will bring. However, it may perhaps be a saving feature of this situation that some of the advantages of more volatile gasolines are simply potential ones which cannot actually be realized unless special provision is made for them in the automobile design.

Recent Trends in Important Items of Design.—It is one of the functions of this meeting to consider some of these changes, and some of the compromises as well, from the standpoint of the experiences of the producers of fuels and the builders of engines. Since experience is proverbially a good, although an expensive teacher, it may be of service to take a look at the past and at some of the trends in engine design which have been influenced by changes in fuels over a period of years. In doing this it is recognized, of course, that it is not possible to predict the future.

There are two outstanding trends in automobile design which have taken place over a period of years. The first of these is the trend toward getting more power out of a given weight of engine (higher specific outputs) and toward getting more energy out of a given weight of fuel (higher fuel economies). The second trend is toward greater reliability in operation. It is difficult to relate these trends to the fuels in any very specific manner, of course. However, these factors seem worthy of consideration as a matter of establishing a background, and as indicating some of the outstanding trends in automobile design.

The first trend, that towards more power and economy, may be represented graphically in a very simple manner. It is a commonplace to observe that cars have become heavier. The average weights of a representative series of cars over a period of years from 1926 to 1934 have been plotted in Fig. 1, and it is clear that the average weight has gone up from around 3700 lb. to around 4700 lb. or has increased above 25 per cent. At the same time the *relative* size of the engines has not increased. As an index of engine size, we have taken cubic feet per ton mile. That sounds like a complicated thing, but it is really very simple; it is merely the amount of space or volume that is swept by the pistons when unit weight of car moves a unit distance; and, to make the final figure come out a convenient number, we use as units cubic feet, and tons, and miles. A graphical portrayal of cubic feet per ton mile over a period of years is shown in Fig. 2; and, while over the period of years there have been ups and downs in the curve, as a whole there has not appeared to be much of a consistent change. Thus there is more car to move, but the size of engine per ton of car weight has not changed to any considerable degree.

As to what it has been possible to accomplish in the way of performance in the light of this situation, we might look at performance in terms of maximum speed. Fig. 3 shows what has happened to the maximum speed of the series of cars under discussion over a period of years. In 1926, the average top speed was about 57 m.p.h., but now it is over 80 m.p.h. This is a big increase to get when the car is heavier and when there is no increase in engine size relative to the car weight.

In terms of economy, the advances have also been considerable. Fig. 4 shows what has happened to miles per gallon over a period of years. Plotted there are ton miles per gallon for this series of cars, at 20 and at 50 m.p.h. While at 20 m.p.h. the gains have not been so very great until quite recently, at 50 m.p.h. there has been an increase of from less than 22 to over 31 ton miles per gallon, or a gain of almost 50 per cent.

These advances, in which performance and ton miles per gallon have both been boosted while cars have gotten heavier

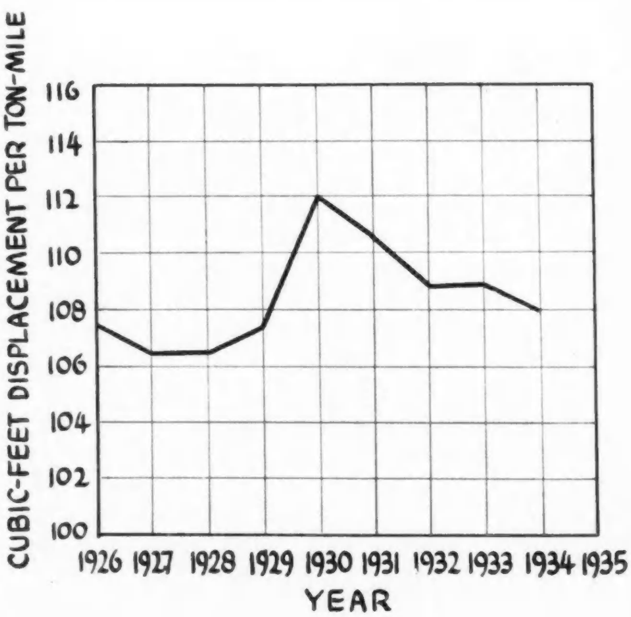


Fig. 2—Average Cubic-Feet Displacement; 1926 to 1934

but relative engine size has not been increased, are not to be considered lightly. They have been due in part to the improved fuels which have become available, chiefly of course in respect to higher octane numbers, but also in part to improved volatilities. There is a great demand from the public for more and more from its cars both in the way of economy and performance and, in his struggle to give the car user what he wants, the automobile manufacturer is anxious to take as much advantage of the improvements which are made in fuels as is possible.

For the last few years there has been a continually shifting balance between the characteristics of the available fuels and the design of the engine which used the fuels. As the fuels which are generally available become better and better, either with respect to volatility or knock rating, the engine designers soon use these characteristics right up to the limit. But in working thus close to the limit some compromises are made in favor of performance and so, under certain conditions, the limit is overstepped. This results in a certain amount of knock or in imperfect operation on some fuels with respect to some characteristic that is affected by fuel volatility. It thus leaves an opening for the forces of competition among gasoline producers to close up. When the gap has been closed, the engine manufacturers then can take advantage of the better fuels generally available at that time, and the cycle is repeated. It believed that this process is a natural one and a desirable one which results in technical progress.

The second one of the outstanding trends in automobile design already mentioned is that toward more reliable operation. The reliability factor has been increased to the point at which the customer is becoming less and less conscious of the mechanism of operation of his automobile. The automobile has evolved, in the mind of the customer, from an intricate mechanical device to a comfortable means of transportation. It was only a few years ago that the owner of a car was primarily concerned with whether it would go or not, with whether it had power to go up hills, and the like. The mechanism was very important then. Today the driver of a car is not much concerned with these things. He takes them all for granted. But the reliability which cars have today

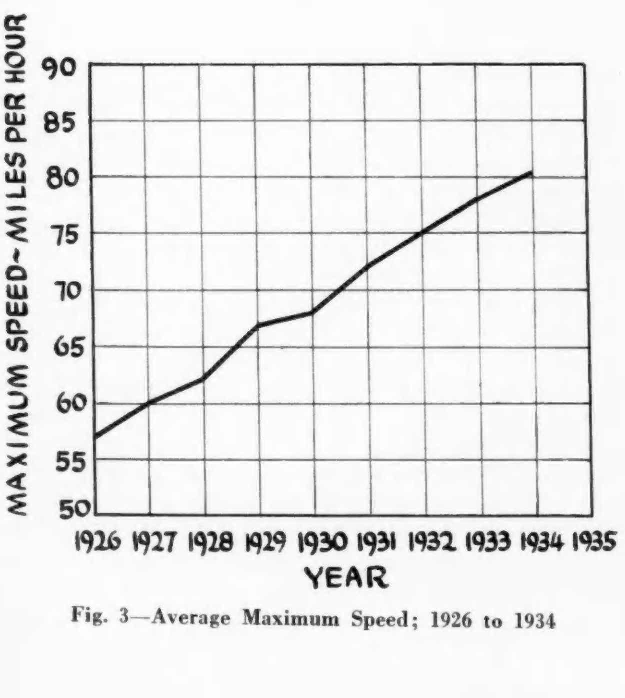


Fig. 3—Average Maximum Speed; 1926 to 1934

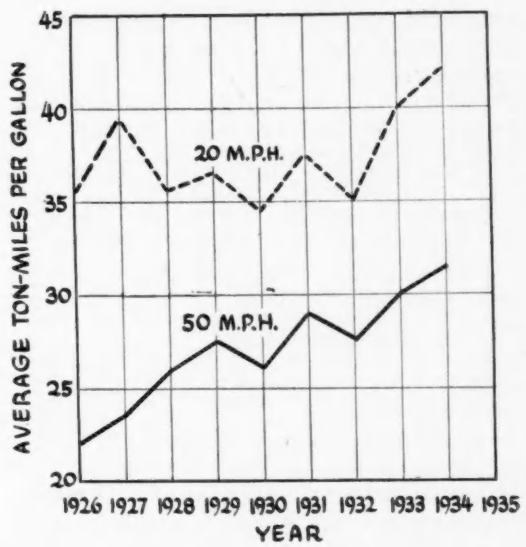


Fig. 4—Average Ton-Miles per Gallon; 1926 to 1934

has been engineered into the car as the result of a great deal of intensive work done over a period of many years.

The Trend to Automatic Chokes and Warm-Up Controls.—One outstanding demand on the part of the public is for the removal of as many dash controls as possible to make operation of the engine as nearly automatic as practicable. Definite evidence of this trend is shown by the increasing adoption of automatic chokes, starting devices, and manifold heat-controls. To express this trend in a quantitative manner, we have computed the percentage of the total makes of cars which have had these devices as standard equipment, covering the models over a six-year period from 1930 to 1935. The data are presented graphically in Fig. 5. These curves show that, while in 1931 no cars had automatic chokes, over half of the makes were so equipped by 1935. Over the period from 1930 to 1935 there appears to have been a very definite trend toward automatic heat control, automatic starting devices, and automatic chokes.

The volatility characteristics of the gasolines being distributed are of importance in relation to this trend. This is so for two reasons. The first reason arises from the fact that, both during starting and the subsequent warm-up period, the automatic choke relieves the driver of the necessity for choke manipulation which, at best, is an operation to be regarded as somewhat of an art. The consequence is that small differences between fuels in regard to the aspects of volatility which have been thought of as being important in this connection are not always brought to the attention of the driver. These automatic devices thus make the relatively small differences in volatility which exist between the conventional gasolines of little consequence to the driver. The second reason why the volatility characteristics of gasolines are of importance in relation to these automatic devices is more critical. It is concerned with those gasolines which differ markedly from the conventional in respect to ease of vaporization, particularly at the lower end of the distillation curve and which, under some temperature conditions, may altogether prevent starting and warm-up.

An automatic choke must be designed for operation on gasolines of definite vaporization characteristics. The reason for this becomes clear upon analysis of what is taking place when the choke is in operation. Immediately after starting,

the choke should be released by a certain amount and just enough so that all cylinders will receive sufficient gasoline to form an explosive mixture in spite of the unequal distribution between cylinders which necessarily prevails during this period and in spite of the fact that only a fraction of the gasoline is actually vaporized to form an explosive mixture with air. This is a critical stage in the operation of an automatic choke because of the narrow range of mixture ratios from 8:1 to 20:1 which will ignite. It is understood, of course, that this range of explosive limits applies to the fuel which is actually vaporized and in the vicinity of the spark plug irrespective of how much liquid gasoline may be present in other parts of the system. If the effective mixture ratio in the vicinity of the spark plug gets outside of these narrow limits, the engine will not run.

Right here is where fuel volatility enters the picture. If the choke is adjusted to give a mixture which will keep the mixture delivered to the cylinders within the explosive limits with a gasoline of conventional vaporization characteristics, missing or actual stopping is likely to occur when the engine is operated on fuels which are either much less volatile or much more volatile than the original fuel for which the choke was adjusted. The less-volatile fuel, although choked by the same amount as the original fuel, gets outside the limit of inflammability on the lean side as a result of unequal distribution and a smaller amount of evaporation, and the more-volatile fuels get outside the range of inflammability on the rich side on account of unequal distribution and a greater degree of evaporation.

It is a matter of experience that an automatic choke may operate well on one gasoline while, on another gasoline, of a volatility lying considerably outside the range of that which might be regarded as conventional, starting may be impossible under some weather conditions. Under such conditions the situation is not a happy one. The automatic choke may of course be made adjustable for different gasolines. But if such an adjustment is put on an automatic device, then the device is no longer automatic in reality, and some would prefer to dispense with the automatic feature altogether. The automatic choke is such a desirable feature that it is hard to take it away from a man who has used one, although it is doubtful whether he would continue to like it if he had to be adjusting it every now and then.

[1] See S.A.E. JOURNAL, October, 1929, p. 345; "Present Status of Equilibrium-Volatility Work at the Bureau of Standards", by O. C. Bridgeman.
[2] See S.A.E. JOURNAL, March, 1927, p. 353; "Fuel Requirements for Engine Starting", by C. S. Cragoe and J. O. Eisinger.

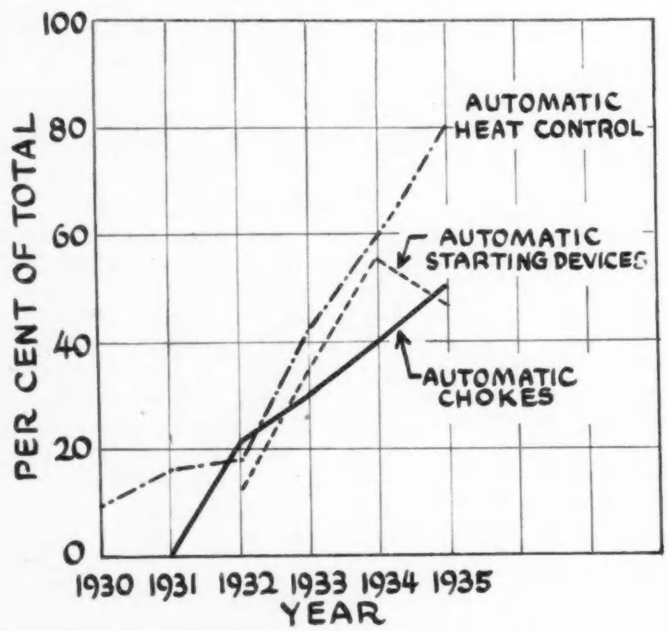


Fig. 5—Trend Toward Automatic-Starting and Warm-Up Devices; 1930 to 1935

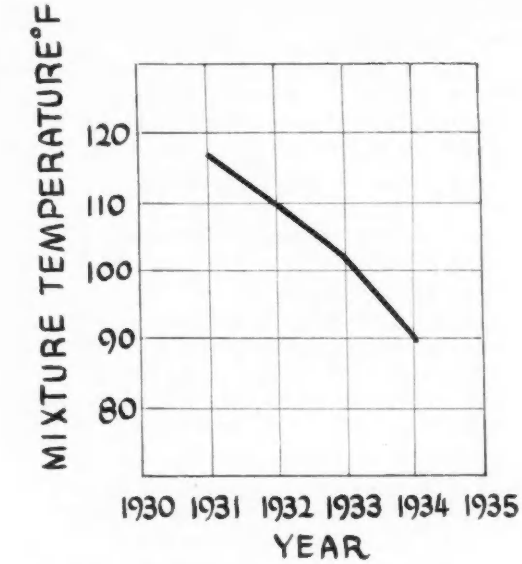


Fig. 6—Trend of Mixture Temperatures; 1931 to 1934

Average of seven representative makes of cars at wide-open throttle and at speeds of 1000, 2000 and 3000 r.p.m.

System of Classifying Gasolines in Terms of Volatility Needed.—Different settings for fuels of different volatilities can be made readily enough, but how is the customer to relate the volatility or the choke setting required with the gasoline that goes into his tank? There is no accepted measure of volatility with respect to starting characteristics to serve as a guide in the setting of such automatic devices. This situation would seem to indicate that, if gasolines are to spread over a wide range in respect to volatility characteristics, there is a definite need for a classification of gasolines according to suitable indices of volatility in its different aspects. Such a classification would not only be of convenience to the customer in selecting the fuel best suited to his particular car, but it might also enable the maker of the car to specify definitely the fuel upon which his product may be expected to operate most satisfactorily.

Other Aspects of the Starting Problem.—The starting problem in general has this aspect of automatic chokes just discussed as only one of its phases. Experience in the past has indicated that satisfactory starting is obtained in winter in most parts of the United States with conventional winter gasolines of the present. These run between 110 and 130 deg. fahr. at the 10-per cent evaporated temperature, and have Reid vapor pressures between 9 and 12 lb. The "theoretical" starting temperatures as interpreted by Bridgeman[1] and by Cragoe and Eisinger[2] thus indicate that starting should not be a serious problem at present insofar as the gasoline is concerned; as, according to their figures, even the gasoline with a 10-per cent point of 130 deg. fahr. should vaporize readily enough to give good starting at temperatures well below zero.

One factor which is often overlooked in connection with the

cold-starting problem is the importance of maintenance of the mechanical equipment. It is essential in most cars to crank above a certain minimum speed with any gasoline or at any temperature. This factor is being recognized in the growing tendency toward the use of lighter oils in winter. It may be that too much attention is being given to the part played in starting by fuel volatility and that the importance of crankcase-oil viscosity is being under-rated in connection with this problem. Troubles in connection with current conventional fuels with starting appear to be ascribable more to oils that are too viscous or to faulty maintenance of equipment than to the use of fuels of unsatisfactory volatility.

After the engine has been started heat becomes available for heating the mixture and a larger proportion of the fuel is vaporized. The fuel volatility as indicated by the 50-per cent point then becomes a more important criterion of quick warm-up than the 10-per cent point. As was shown in Fig. 5, a very large percentage of new cars now have automatic heat control on the intake manifold for hastening the warm-up and for cutting off the heat after warm-up has been completed to avoid excessive heating at operating temperatures. The effect of this automatically controlled warm-up is to shorten the period during which the driver may be conscious of differences between gasolines with respect to warming-up characteristics.

The Trend in Mixture Temperatures.—One requirement of every induction system is a reasonably uniform distribution of the fuel to all the cylinders with all kinds of fuel and in all kinds of climates. Good distribution makes possible operation at lean mixtures; poor distribution makes it necessary to employ relatively rich mixtures to put enough fuel into every cylinder for the engine to give optimum performance. To obtain uniform distribution in existing induction systems, heat must be applied to the intake manifold. Of course it is desirable to keep the amount of heat added to the intake manifold at a minimum for satisfactory all-round operation, and right here certain practical compromises depending upon the manufacturer's judgment have to be made.

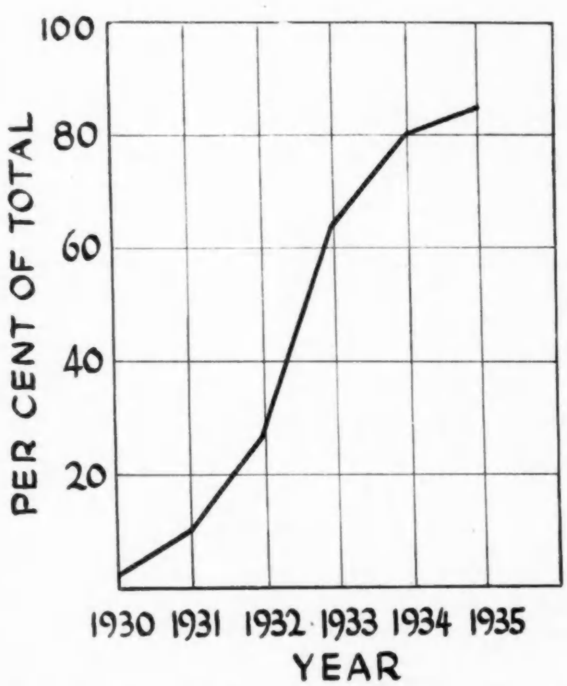


Fig. 7—Trend Toward Downdraft Carburetion; 1930 to 1935

This curve represents an average of all makes of cars.

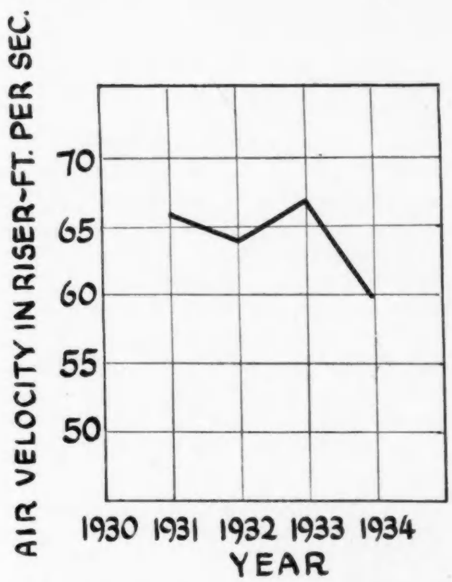


Fig. 8—Trend in Air-Flow Rates in Manifolds; 1931 to 1934

This curve shows an average of seven representative makes of cars, with wide-open throttle at 1000 r.p.m.

Since there is a general relationship between fuel volatility and the amount of heat that must be applied to the mixture, it would be desirable in a discussion of this kind to know the trend of mixture temperatures in current automobiles. A limited amount of data on the downward trend in mixture temperatures for a representative group of passenger-car engines is shown in Fig. 6. This illustration shows that in these cars there has been a drop in mixture temperature during the last four years of nearly 30 deg. fahr. These mixture-temperature figures are presented with full realization of the shortcomings of mixture-temperature measurements as ordinarily made. However, since these measurements were all obtained under comparable operating conditions and by a standard technique, they do indicate a definite trend toward the application of less heat to the intake manifold.

It should be noted that these mixture temperatures are now not unreasonably high; and it should be noted, further, that even if the hot spot were removed altogether the resulting power increase that could be obtained with a fuel of suitable volatility would only be of the order of 3 to 5 per cent. The real potential advantage of the more-volatile fuels appears to be not that they would allow reductions in manifold temperature but that they might permit higher volumetric efficiencies by allowing further reductions in manifold restrictions. Some indication of the trend in the direction of reduced restrictions in inlet manifolds is indicated by the swing toward downdraft carburetion which has gone along with it. This trend is shown in Fig. 7. Downdraft carburetion which in part has been thought of as a means of relieving the necessity for high manifold velocities to carry the fuel in the gas stream, has evidently come in very fast in recent years.

Another aspect of this same problem is represented in Fig. 8 in which the computed riser velocities in feet per second have been plotted against years for a representative group of cars. There is some evidence of a decrease in riser velocity at constant engine-speed over a period of years, and it would

perhaps not be unreasonable to expect a further change in this in the future. Then, too, the fact that maximum car speeds have increased greatly over this period of years should not be lost sight of.

Acceleration.—Another important phase of engine operation that is sensitive to fuel volatility is the ability to accelerate smoothly without missing. The engine must respond immediately to the throttle, and one important function of the hot spot on the intake manifold is to assist in the rapid vaporization of the fuel when the throttle is opened suddenly. Present-day carburetors usually have some provision for supplying extra fuel during the initial part of the accelerating period, and in some of these devices provision for seasonal adjustment is made. The same type of adjustment is applicable to fuels of different volatilities, although its use in this connection has not been very widely recognized. Here, again, there appears to be a need for some suitable and generally accepted index of the volatilities of automobile gasolines in order that carburetor adjustments may be made to fit the volatility of the fuel.

Crankcase Dilution.—Nearly all makes of 1935 cars have crankcase-ventilation systems as compared to 80 per cent of the cars in 1933, and the problem of crankcase dilution does not seem to be of much concern today. How widespread is the use of crankcase ventilation may be seen from Fig. 9, in which the percentages of the cars with crankcase ventilation at different years are represented.

Vapor Lock.—The remaining aspect of volatility, and one of the most positive in its action, is the tendency toward vapor lock. Although vapor lock and cold starting are reasonably well correlated with the 10-per cent evaporated temperature or the Reid vapor pressure, the experience has been that cold starting is primarily a winter problem and that vapor lock appears mostly in the late spring and early summer. It is not generally that these two phenomena are experienced in the same season of the year.

Because of the critical nature of vapor lock, there is particular need for a close tie-up between the fuel and the automobile in respect to the matter of vapor lock. Cars designed for one type of fuel at certain atmospheric temperatures will not necessarily operate satisfactorily on some other fuel or in unseasonable weather. Distinct improvements have been made in cars, however, with respect to freedom from vapor lock. These improvements have usually been made by one or both of two general methods: first, by reducing fuel-line temperatures; second, by increasing the vapor-handling capacities of fuel systems. That definite progress has been made in reducing fuel-line temperatures is shown by the data given in Table 1. The figures given in this table represent results from five different makes of cars over the five-year period, 1929 to 1934. In these cars during this period a reduction of about 15 deg. fahr. in maximum fuel-line temperature-rise above atmospheric temperatures during steady driving at 60 m.p.h. and in idling appears to have been accomplished. These reductions were made largely by better locations of the fuel lines, and they had to be realized in spite of increased engine sizes and correspondingly larger amounts of heat dissipated by the engines. The reductions in temperature thus accomplished are equivalent to an increase in permissible Reid vapor pressure of about 2 lb.

Changes have also been made in carburetor design to increase the vapor-handling capacity of fuel-handling systems. Nearly all cars today are equipped with fuel pumps, and these have large vapor-handling capacities. Some indication of the progress that has been made in this direction may possibly be had from the fact that in 1931 Bridgeman[3] estimated the vapor-handling capacity of a group of 1931 cars to be about one volume of vapor to one volume of liquid. In an examination of a group of 1934 cars which we made, a vapor tolerance of from 15 to 30 volumes of vapor per volume of liquid at the time of vapor lock was found.

Table 1—Changes in the maximum temperature rises in the fuel systems of five representative cars over a 5-year period. Showing an average reduction of about 15 deg. fahr., which corresponds in turn to a boost of approximately 2 lb. in permissible Reid vapor pressure

	1929 Cars,		1931 Cars,		1934 Cars,	
Car	Steady Driving	Idling Afterward	Steady Driving	Idling Afterward	Steady Driving	Idling Afterward
No. 1	29	67	37	65	25	38
No. 2	45	61	50	69	42	55
No. 3	57	81	52	67	27	48
No. 4	58	85	..	..	38	85
No. 5	..	..	44	66	31	60
Average	47	73	46	66	33	57

Conclusion

Looking at all of these trends it appears evident that, over the period of years under consideration, there has been considerable change in those aspects of car design which are related to fuel volatility. It seems likely that changes will continue to be made both in fuels and in cars. There will thus be need for the fitting of fuels to engines and engines to fuels to the best advantage of the user, and here it is important to remember that the automobile manufacturer and the gasoline producer are trying to please the very same people.

[3] See S.A.E. JOURNAL, December, 1931, p. 447; "Fuel-Line Temperatures in Cars of 1931", by O. C. Bridgeman and H. S. White.

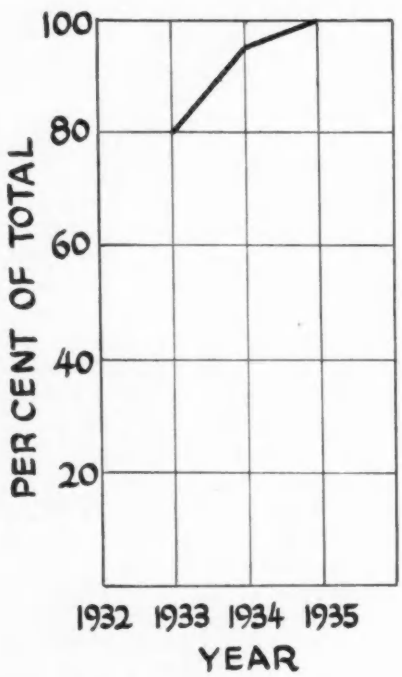


Fig. 9—Trend in Crankcase Ventilation; 1933 to 1935
This curve represents an average of all makes of cars.

What Members Are Doing

J. H. McDuffee, since 1927 vice-president of the Prest-O-Lite Storage Battery Co., has been advanced to the presidency of the company, according to an announcement from

D. H. Kelly, executive vice-president of the Electric Auto-Lite Co., and chairman of the board of Prest-O-Lite.

G. M. Bellanca has been named chairman of the board of the Bellanca Aircraft Corp.,

G. M. Bellanca

New Castle, Del., and has been succeeded as president of the company by

Lieut. Col. Temple N. Joyce, formerly of the Berliner-Joyce aircraft manufacturing organization. The elections date from June 22.

Col. Oliver B. Zimmerman, a life-member of the S.A.E., has been elected an honorary member of the American Society of Agricultural Engineers.

A. M. Fish is doing engineering work with the Ingersoll Milling Machine Co., Rockford, Ill.

W. L. Batt, president, SKF Industries, Inc., Philadelphia, left recently for a European trip. Mr. Batt has been nominated as president of the American Society of Mechanical Engineers. His connection with the S.A.E. dates from 1914.

Nils Fredriksson has been named president of the Standards Commission of Sweden by H. M. the King of Sweden, succeeding Axel F. Enstrom. Mr. Fredriksson has been a member of the SIS, a cooperating body in the promulgation of S.A.E. Standards, since its inception in 1922. He is Counsellor of the Board of Education of Sweden.

L. W. Shank, secretary of the Baltimore Section and assistant division manager for the Ethyl Gasoline Corp., has been appointed Baltimore division manager for the corporation, succeeding

Oscar B. Lewis, who has been transferred to New York as assistant sales manager of the corporation.

C. B. Gwyn, Jr., for the past six years chief engineer, contacts, P. R. Mallory & Co., Indianapolis, Ind., now has a similar position with the Fansteel Products Corp., North Chicago, Ill.

E. W. Fawcett, formerly manager, Independent Lubrication Co., Topeka, Kan., is now secretary, Kansas Oil Men's Association, Wichita, Kan.

C. H. Dolan, II, has opened an office as consultant on air-transport engineering in the Southern Bldg., Washington, D. C. Having completed an assignment as aeronautical valuation engineer (special assistant to the solicitor) of the Post Office Department, Mr. Dolan has been engaged for several months in research on costs of operation for foreign and domestic air-mail lines.

Chester R. Wells, formerly research and development engineer with the Patent Engineering Corp., Buffalo, N. Y., has been appointed chief engineer of the Rockwell Products Co., Hartford, Conn.

George M. Hansen, formerly with the White Co., at Buffalo, N. Y., has joined the Westinghouse Electric & Mfg. Co. at Springfield, Mass.

Several members of the Society connected with the United Aircraft Corp. and its subsidiaries have received new titles consequent upon the formation of the United Aircraft Mfg. Corp. to consolidate subsidiary operations of the corporation.

E. E. Wilson becomes senior vice-president of the new organization, retaining also his vice-presidency in the parent company.

In the former companies which now figure as divisions of the United Aircraft Mfg. Corp.:

A. V. D. Willgoos is chief engineer of the Pratt & Whitney Aircraft Division.

F. W. Caldwell is engineering manager of the Hamilton Standard Propellers Division.

C. J. McCarthy is engineering manager and *Rex Beisel* is chief engineer of the Chance Vought Aircraft Division.

I. I. Sikorsky is engineering manager of the Sikorsky Aircraft Division.

George A. Zamboni, formerly Northwest representative of the Sinclair Refining Co., has joined the Rio Grande Oil Co., Los Angeles, as sales promotion manager.

T. P. Wright, past vice-president of the Society, has been named director of engineering of the Curtiss-Wright Corp., at headquarters of the corporation in New York. Before taking up his new assignment Mr. Wright was general manager of the Curtiss Aeroplane & Motor Co., Buffalo.

Isaac Char is now in the engineering department, Chevrolet Motor Co., Detroit, Mich. He formerly was owner, designer and engineer, Char Engineering Works, Los Angeles, Calif.

H. Albert Hansen, formerly engineer in the marine department of the carburetor division of the Bendix Products Corp., has been assigned to be in charge of sales and engineering of the marine carburetor division for both Stromberg and Zenith products. His office is with the Zenith Carburetor Co., Detroit.

André Citroën

André Gustave Citroën, until a few months ago owner and operator of the largest independent automobile plant outside the United States, died July 3 after a long illness.

Only 57 at the time of his death Monsieur Citroën had packed with brilliant achievement the years since the beginning of the World War and it was said of him finally that he was an engineer by preference and a financier only through necessity.

At the outbreak of the World War he was mobilized as lieutenant of Artillery, but soon found opportunity to turn his latent genius to a reorganization of the Army Post Delivery System in France. A shortage of shells gave him opportunity to apply American principles of mass production to munitions. Within a few months he had built and put into production a plant issuing 20,000 shrapnel shells per day.

After the war he turned to automobiles. Within a few brief years he was operating four immense plants in the Paris area and assembly plants in several other European countries. Production of Citroën cars reached a peak of 84,000 in 1929-30, an immense and unparalleled figure for European automobile manu-

(Obituaries continued on page 30)

André Citroën

Chrysler Realigns Management; Four S.A.E. Members Involved

K. T. Keller, long active in the affairs of the Society, has been named president of the Chrysler Corp., in an announcement carrying news of management changes at Chrysler involving in a prominent way three other S.A.E. members.

In continuing as chairman of the board and chief executive, *Walter P. Chrysler* announces the appointment of *Fred M. Zeder* as vice-chairman of the board.

B. E. Hutchinson, formerly treasurer of the corporation, has been made chairman of the finance committee. Mr. Hutchinson is an associate member of the Society.

Messrs. Keller and Zeder have served the Society many times in important advisory capacities. Mr. Keller, a frequent and favored speaker before the production Activity, presented a paper at the Annual Meeting of the Society in Detroit, January, 1933, which is still remembered as a contribution to the philosophy of labor relations in production. The paper, under the title "Leadership and Labor Are the Twin Problems of Industry," was printed in the April, 1933, issue of the S.A.E. Journal.

News of the Society

Section Holds Roll-Call Meeting

● No. California

The annuall roll call of the Northern California Section was held at the May 21 meeting. New members of the Section were welcomed and all those present were asked to get up and state their name, business connection and the salient features of the products in which they were interested.

C. H. Schildhauer, operating manager, Pacific Coast Division of Pan American Airways, gave an informal talk on the service operations planned for trans-pacific flying made at the Alameda Airport.

Plans were discussed for a Pacific Coast Regional Meeting of the S.A.E. to be held Nov. 15 and 16, 1935, at Los Angeles, immediately following the convention of the American Petroleum Institute. E. C. Wood, S. Shaw, B. H. Mosel and J. M. Evans, constitute the committee for this meeting under the supervision of the Board of Governors of the Section.

Oregon Miscellany

Several activities of the Oregon Section are continuing without interruption in the Summer months. With six committees functioning actively, the annual picnic of the Section was an immense success in all departments. Barbecuing of a quarter of a beef by Bob Mann was the high spot. Dancing in the evening followed, games, swimming, boating and food during the day.

On the evening of June 20 an informal meeting of student members was held at Portland with nine student members and seven prospective members attending. Eleven students who graduated from Oregon State College in the class of 1935 were assisted by the Section in finding positions and five graduates were placed in summer jobs.

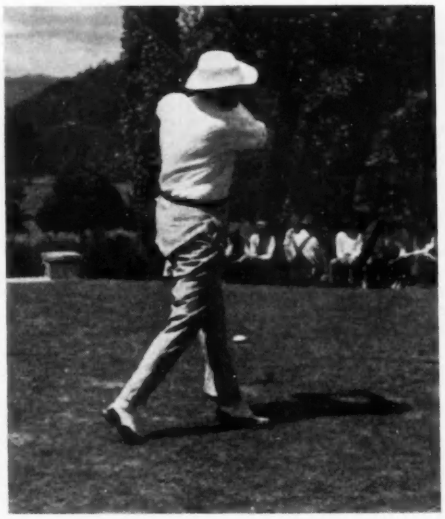
With a Student Branch of the Society having been authorized by the Council as reported elsewhere in this issue of the S.A.E. JOURNAL, the Section had written officially to the president of the College requesting permission to proceed with the establishment of the branch.

Reguar weekly luncheons held by the Section are continuing to draw an average attendance of 18 or 20. At the luncheon on June 21, Col. Fred L. Dennis, director of Highway Safety, Bendix Corp., was guest speaker. On July 12, H. W. Roberts, a member of the Section, told of a recent visit to Mexico City.

Offers Attendance Prize For Ex-Members

During its past season the Milwaukee Section offered an attendance prize of one year's dues to the ex-member showing the best attendance record for the season. A. F. Bocksruker, draftsman with the Allis-Chalmers Mfg. Co., Milwaukee, was the winner of the prize, and his dues for a year have been paid by the Section.

Caught By Members' Cameras at Summer Meeting



Camera enthusiasts were busy at the Summer Meeting of the Society held at White Sulphur Springs, June 16-21. The two top photographs, taken by Herbert L. Sharlock, who as chairman of the Golf Committee picked two winners. C. Eustace Dwyer, winner of the men's golf tournament, and Sandford Brown, the runner-up, are following through in the top pictures, left to right.

The busy camera of Hector Rabezzana caught Past-Presidents David Beecroft and H. W. Alden speaking at the 30th Anniversary Party.

New Probationary Section Authorized

Establishment of a probationary section of the Society in the region centering at Hartford, Conn., the scene of two recent successful Regional Meetings, was authorized by the Council of the Society at its White Sulphur Meeting.

The petition to the Council for establishment of a probationary section for Southern New England was supported by many letters from members and friends in the area including C. B. Whittelsey, past-treasurer, and Vice-President Chatfield who are residents of Hartford. A motion authorizing the probationary section was made by Mr. Chatfield to the Council.

The Regional Meeting referred to above had an aggregate attendance of 500 and drew many spontaneous expressions on the desirability of establishing a section. The Metropolitan and New England Sections of the Society cooperated generously in arranging the Regional Meetings and have indicated their support of the fledgling Section.

Engineering Relations To Be Guided

At a meeting of the Council on June 16, the special committee appointed to consider Coordination of S.A.E. National and Sectional Activities in Regulatory and Legislative Matters, presented a report which, with slight amendment, was adopted. This report provides for a central committee, to be known as the S.A.E. Engineering Relations Committee, to consist of five men, three of whom shall be appointed by the President and approved by the Council, the other two men to be the chairmen of the Research and Standards Committees ex-officio. The three presidential appointees as provided in the amendment to the report shall on the first appointment serve for one, two and three years respectively, subsequent appointments to be made on the three-year basis as the terms of the first appointees expire. The committee shall be responsible to the Council and shall report to it.

The committee shall be responsible for maintaining contact with the Sections through an individual liaison representative in each Section to be appointed by the President of the Society upon recommendation of the committee as may be required. The responsibility of the committee is set forth in the adopted report as follows:

"In order that local activity on legislative matters may have the benefit of the prestige accruing through endorsement by the parent Society, all contact of Sections with legislative or regulatory bodies shall be with the knowledge and approval of the Committee, and information or assistance given by such bodies shall be limited to technical data obtained through or furnished by the Committee.

"The S.A.E. Engineering Relations Committee shall be administrative in character; its duties shall be: to collect information, functioning largely through regular or special committees of the Society; to furnish, insofar as possible, to the Sections through its liaison representatives such information in this field as is requested; to anticipate, to this end, the need for such information and have it readily available; and to examine into and pass upon the desirability of any Section furnishing technical information in a given instance."

O.S.C. Gets Student Branch

Establishment of an S.A.E. Student Branch at the Oregon State College at Corvallis was authorized by the Council at its meeting of June 16.

Request for establishment of the branch came through the Oregon Section of the Society which has been extremely active and successful in its relation with the college and engineering students. The Section has arranged for the Mechanical Engineering Department of the college to receive valuable automotive equipment donated by more than a score of the companies represented in the sections by members and friends.

At a recent Engineers' Day held at the college, members of the Section met to hear a student thesis by E. J. McLaughlin on the comparative efficiency of various methods of valve grinding. The paper was very well received and Mr. McLaughlin was suitably rewarded by the Section for his efforts.

S.A.E. Production Meeting Planned for Sept. 18-19

THE S.A.E. Production Meeting this year is to be held again in Cleveland in conjunction with the Machine Tool Congress, which will be in full swing from Sept. 11 to 21 under the auspices of the National Machine Tool Builders Association. Although the Society will not participate in the machine tool exposition at the Cleveland auditorium, it is cooperating in the Congress by holding two evening technical sessions.

The session on Wednesday evening, Sept. 18, will be a symposium of four brief technical papers and informal discussions on subjects of outstanding interest and importance to production men at this time, and a brief review or "thumb nail" sketch of what new and improved machine tools and production processes may be seen and studied at the Exposition.

The second session, Thursday evening, Sept. 19, will be an informal production dinner under the auspices of the Society's Cleveland Section and will feature a most interesting and valuable presentation immediately following the dinner, on the influence and relation to each other of production and engineering.

The speakers for both sessions are men of many years of broad experience in their respective fields, who know their topics thoroughly and can present them clearly and attractively. They are restricting their papers to what is essentially new in each field of production activity, so that he who might want to "listen while he runs" can get the most message in the fewest minutes. Opportunity will be given, of course, for crisp, brief discussion of each topic after it is presented.

During the ten days of the general Machine Tool Congress and Exposition, technical sessions are also being scheduled by the Machine Shop Practice Division of the American Society of Mechanical Engineers on Sept. 11 and 12, and by the American Society of Tool Engineers on Sept. 13. As the Exposition will be open only during the mornings and afternoons, there will be no overlapping with the evening technical sessions of the Societies cooperating in the Congress.

Reduced railroad fare certificates will be available to members of the Society and the immediate members of their families, entitling them to a round trip for one and a third fare. Information furnished to the Society indicates that advantages such as reduced fares may be had by individuals and companies who are not members of the Congress or any of the cooperating bodies named above. Full information as to these provisions may be had from the National Tool Builders Association, Cleveland, Ohio.

Tickets for the S.A.E. Production Dinner, at the Hotel Statler, Cleveland, may be obtained in advance through the Cleveland and the Detroit Sections and at the Society's office in New York City. The dinner will be strictly informal, and as places will not be reserved, members can organize their own tables.

The planning and arrangements for the Meeting have been under the jurisdiction of the S.A.E. Production Activity Committee of which vice-president V. P. Rumely is chairman, and Joseph Geschelin is vice-chairman. Mr. Geschelin has also been chairman of the Production Meetings Committee for a number of years, and the time and efforts of the Committees under these leaders have resulted in the selection of a program and speakers of exceptional interest. The members of the Production Activity Committee are: H. D. Allee, J. W. Brussel, F. H. Colvin, R. S. Drummond, P. W. Fassler, James Fletcher, Otto Graebner, R. C. Hoffman, W. B. Hurley, W. H. McCoy, W. W. Nichols, J. E. Padgett and E. R. Smith.

S.A.E. Production Meeting

Sept. 18 and 19 Hotel Statler, Cleveland

(In conjunction with Machine Tool Congress, Sept. 11-21, 1935)

Wednesday Evening, Sept. 18

Technical Session—JOSEPH GESCHELIN, chairman (Chairman, Production Meetings Committee)

(1) Methods of Finishing Transmission Gears —S. O. WHITE, Warner Gear Co.
(2) Application of Induction Heating in Automotive Production—E. L. BAILEY, Dodge Bros. Corp.
(3) Rustproofing and Paint Adherence Technique — E. P. SPRUANCE, American Chemical Paint Co.
(4) Resistance Welding in the Automotive Industry—J. A. WEIGER, P. R. Mallory & Co.
(5) A Quick Trip to the Machine Tool Exhibit—JOHN R. COX, Thompson Products, Inc.

Thursday Evening, Sept. 19

Production Dinner Session (Sponsored by Cleveland Section)

A. T. COLWELL, chairman
(Chairman, Cleveland Section)
V. P. RUMELY, toastmaster
Vice-President, Production Engineering Activity, S.A.E.

The Relation Between Manufacturing and Engineering—D. G. Roos, chief engineer, Studebaker Corp. of America; Past-President, S.A.E.

Dinner Tickets, $1.50 each Informal

Papers Available in Mimeographed Form

UNTIL current supplies are exhausted, copies of the papers listed are available in mimeographed form at a cost of 25 cents per copy to members; and at 50 cents per copy to non-members. Orders should specify the name of the author as well as the title of the paper desired.

Orders must be accompanied by remittance and should be addressed to Sessions Secretary, Society of Automotive Engineers, 29 West 39th St., New York, N. Y.

Alden, C. R.
Design and Development of Injection Apparatus for High Speed Diesels

Allee, H. D.
Quill Bearings—Past, Present and Future

Altman, Peter
Sales and Technical Problems of Private Commercial Airplanes

Ballard, J. H., and Moore, N. A.
How the Design of Some Motor Parts Can Influence Piston Ring Performance

Ballard, J. H., Nixon, S., and Moore, N. A.
Piston Rings: Factors Contributing To Their Normal and Abnormal Wear

Becker, C. F.
Factors Affecting Gasoline Consumption in Automotive Vehicles

Blanchard, H. F.
A Discussion of 1935 Cars

Britton, Roy F.
Taxation and Regulation as Applied to Highway Transportation

Browne, K. A.
Comparison of Spark and Compression Ignition Engines for Aircraft Service

Bull, A. W.
Rubber and Its Uses in Transportation

Burwell, A. W. and Camelford, J. A.
A New Idea in Lubrication

Camp, R. H.
The Supercharger

Campbell, Kenneth
Evaluation of Variables Influencing Air Cooling of Engines

Clinton, G. E.
Problems of Industry in Using the Highways

Cosford, E. J.
Outlook for High-Speed Diesel-Engine Application to Road Transport Vehicles

Cram, R. L.
The Measurement of Landing Speed and Other Flight Test Procedure

Creson, W. K.
Steering Safely

Croll, P. R., and DuBey, L. E.
How to Finish a Truck

Debbink, H. S.
Some Factors Influencing Gasoline and Oil Consumption

De Forest, A. V.
Surface Integrity and Dynamic Strength

DeJuhasz, K. J.
Analysis of Surges in Fuel Injection Pipes

DeSmet, E. C.
The Practical Side of Planography

Dick, Burns
Hydraulic Brake Actuation

Dunbar, H. W.
1934 Developments in Cam and Cylindrical Grinding

Elden, H. E.
The Properties of Cellular Rubber for Passenger Car Cushions

Fassler, P. W.
Modern Resistance Welding in the Automobile Industry

Field, H. W. and Fowle, M. J.
Economics of Gasoline Volatility from the Refining Viewpoint

Gebhardt, W. A.
A Study of the Efficiencies of Overdrive Units Used in Passenger Cars

Geisse, J. H.
Air Transportation Equipment for the Private Owner

Geniesse, J. C.
Fuel and Oil Economy for the Operator

Greene, C. F.
Aircraft Structural Design and Its Influence on Other Engineering Design

Gurney, E. R., and Brown, L. H.
Technical and Economic Phases of Railroad Automotive Development

Hardy, F. I.
Economic Application of Rates for Movement of Freight by Motor Trucks

Holzapfel, G. L.
The Future of Butane as a Motor Fuel

Horine, M. C.
Motor Truck Transportation—Its Development and Future Possibilities

James, W. S., Churchill, H. E., and Ullery, F. E.
"Sky Hooks" for Automobiles (Suspensions)

Jorgensen, C. H.
What Price Dynamite?

Kemper, Carlton, and Wood, D. H.
The N. A. C. A. Investigation of Cowling and Cooling of Radial Air-Cooled Engines

Larsen, A. E.
The Future of the Autogiro for the Private Flyer

Larson, C. M.
The Realm of Extreme Pressure Lubricants

Leeds, Norman, Jr.
Problems in Heavy Duty Automotive Brake Design and Maintenance

Littlewood, William
Operating Requirements for Transport Airplanes

Lott, E. P.
Air Transport Operations

MacCoull, Neil, and Stanton, G. T.
Engine Knock Studied by Electro-Acoustical Instruments

Markham, H. B.
Trend in Taxation and Regulation of Highway Transportation

Martland, R. W., Jr.
How Car Manufacturers Can Cooperate with the Commercial Fleet Operators

McDonald, A. F.
Maintenance and Cutting Maintenance Costs

Merriman, M. E.
Bringing the Italian Sky Down to Earth

Nohavec, F. R.
Air Conditioning as Applied to Internal Combustion Engines

Oberfell, G. G., Alden, R. C. and Trimble, H. M.
The Trend of Volatility of Motor Fuels

Padgett, J. E.
Machinery and Equipment Policies in View of the Present Business Situation

Preble, T. L.
How to Buy a Truck

Preble, T. L.
Principles of Fleet Operation

Probst, K. K.
Transverse Leaf, Independent Springing

Reed, James
Our Accident Prevention Method

Reid, Elliott G.
Some Flying Problems

Robertson, D. D.
Factors Governing Performance of Pistons and Piston Rings

Sampson, P. J.
Valves for Internal Combustion Engines, and Their Related Parts

Saurer, Curt
Engineering Uses of Rubber

Schumacher, Lieut. Comm. T. L.
Chemical Warfare

Shoemaker, J. M., Rhines, T. B., and Sargent, H. H., Jr.
Further Progress in Controlled Cooling of Radial Aircraft Engines

Sloan, W. J.
Planning and Administering Highway Systems for Greatest Usefulness

Sneed, John
Mechanical Mind Reading (Transmissions)

Spencer, D. P.
Development of Electric Cast Iron

Spring, F. S.
Are We Giving the Average Private Operator the Airplane Most Suitable to His Needs?

Taylor, C. F.
Critical Stresses in Aircraft Engine Parts

Taylor, C. P.
Fitting the Highway to Traffic

Tinkham, G. L.
Truck Refrigeration with Propane

Treiber, O. D.
Diesel Power for Transportation

Van Deventer, F. M.
Carbon Monoxide in Moving Vehicles

Wait, Louis
Aircraft Instruments and Their Uses

West, C. L.
The Practical and Economic Application of Special Atmospheres in the Heat Treatment and Brazing of Metals

Whitney, E. G.
Performance of High-Speed Compression-Ignition Engines with Three Types of Combustion Chambers

Winchester, J. F.
Operation and Maintenance

Winkler, A. H.
Service Problems and Trends in Motor Vehicle Maintenance

Wise, W. F.
Single Point Boring of Cylinders and Diamond Turning of Pistons

Wittek, H. L.
Diesels on Canadian Roads

New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between June 10, 1935, and July 10, 1935.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Abbott, Ernest J. (M) research physicist, University of Michigan, Ann Arbor, Mich.; (mail) 1608 Ferndale Place.

Adams, Austin Allen (M) airplane designer, Seversky Aircraft Co., Farmingdale, L. I., N. Y.; (mail) 915 North Mulberry Avenue, Hagerstown, Md.

Alexanderson, Howard A. (J) junior engineer, Eclipse Aviation Corp., East Orange, N. J.

Axelson, Oscar A., Capt. (M) automotive engineer, Columbia Gas & Electric Corp., 61 Broadway, New York City.

Black, James J. (M) chief engineer, Trailer Co. of America, 33rd & Robertson, Cincinnati, Ohio.

Blair, Thomas S. (M) sales engineer, H. L. Doherty & Co., 60 Wall Street, New York City.

Borgquist, John W. (J) gear matcher, Buick Motor Co., Flint, Mich.; (mail) 136 West Hamilton Avenue.

Borton, Omar (M) service manager, Autocar Sales & Service Co., 555 West 23rd Street, New York City; (mail) 3752 80th Street, Jackson Heights, L. I., N. Y.

Bray, Wilson C. (A) manager, truck and bus tire department, B. F. Goodrich Co., Akron, Ohio.

Brunton, Mott Q. (A) president, Julius Brunton Sons Co., 1380 Bush Street, San Francisco.

Cender, Elvin O. (J) designing engineer, Gra-Jen Equipment Co., 359 West 45th Street, New York City; (mail) 1560 Broadway, Room 301.

Clark, Edwin Joseph (F M) service manager, Sanderson & Holmes, Ltd., Derby, England; (mail) Thornleigh, Mackworth.

Comstock, C. A. (M) chief inspector, Fafnir Bearing Co., New Britain, Conn.; (mail) 106 Harrison Street.

Coy, Frank (A) superintendent, McQuay Norris Mfg. Co., Ltd., Mount Dennis, Ont., Canada.

Davis, Garland H. B. (M) assistant director, Esso Laboratory, Standard Oil Development Co., Post Office Box 485, Elizabeth, N. J.

Doerr, Charles Schuyler (J) shop superintendent, Atlantic Refining Co., 260 South Broad Street, Philadelphia; (mail) The Linden, Lansdowne, Pa.

Dowling, Chester E. (A) service superintendent, George P. Peterson, 1150 Fifth Avenue, Oakland, Calif.; (mail) 1024 Oxford Street, Berkeley, Calif.

Edwards, Ralph D. (M) superintendent, overhaul and repair, United Air Lines, Cheyenne, Wyo.

Felt, Arthur E. (J) foreman, Henderson Produce Co., Laclede, Mo.

Fleischer, Russell E. (A) manager, Colyear Motor Sales Co., Seattle, Wash.; (mail) 1021 East Pine Street.

Hall, Walter (M) vocational mechanical drafting instructor, John C. Frement High School, Los Angeles; (mail) 3010 Patricia Avenue.

Herrick, James (A) Caterpillar Tractor Co., Peoria, Ill.; (mail) 1002 North Street.

Herschel, Carl (J) draftsman, U. S. Rubber Products, Inc., 549 East Georgia Street, Indianapolis; (mail) 5028 East New York Street.

Holland, L. D. (A) western sales manager, E. F. Houghton & Co., 563 Second Street, San Francisco.

Holland, T. L. (A) president, Anglo-American Chemical Corp., 801 Hardt Building, Broad and Columbia Ave., Philadelphia.

Hoover, Ray B. (M) secretary, treasurer, general manager, Shafer Bearing Corp., 6501 West Grand Avenue, Chicago.

Johnson, Glenn W. (A) superintendent, transportation, Bowman Dairy Co., 140 West Ontario Street, Chicago.

Kauffman, Frank Edgar (A) engineer, American Hammered Piston Ring Co., Bush and Hamburg Streets, Baltimore, Md.

Kilbey, Alfred John (F M) liaison engineer, Oldham & Sons, Ltd., Denton, Manchester, England; (mail) "Sted Combe" Charterhouse Road, Orpington, Kent, England.

LaMont, H. D. (A) treasurer, assistant manager, Asbestos Mfg. Co., Huntington, Ind.

Levenstein, Sherman T. (J) research metallurgist, Federated Metals Corp., 11630 Russell St., Detroit.

Linthicum, Charles M. (A) agent, Gulf Refining Co., Fairfield, Baltimore, Md.

Lochner, Fred (A) maintenance manager, Pulaski Trucking Corp., 471 20th Street, Brooklyn, N. Y.; (mail) 214-10 113th Avenue, Bellaire, L. I., N. Y.

Markus, Alfred (A) treasurer, manager, Markus Motor Service, Inc., Lowell, Mass.; (mail) 12 Thorndike Street.

(Continued on following page)

McCarron, John J. (M) superintendent, Consolidated Telegraph & Electric Subway Co., 54 Lafayette Street, New York City; (mail) 3346 Polo Place.

McGregor, David Laurie (A) shop foreman, Hal Hillman Motors, Portland, Ore.; (mail) 3403 North East 49th Avenue.

Melhuish, Maurice (F M) director, Glacier Metal Co., Ltd., 368 Ealing Road, Alperton, Middlesex, England.

Morris, Benjamin F. (M) vice-president, division manager, Thomas A. Edison, Inc., Emark Battery Div., Kearny, N. J.; (mail) 71 Park Avenue, Caldwell, N. J.

Nixon, Thomas Hay, Capt. (S M) U. S. Army, Ordnance Department, Room 3702 Munitions Building, City of Washington.

Pierce, Erold Francis (J) test engineer, Wright Aeronautical Corp., Paterson, N. J.

Piron, Emil H. (M) engineer, Electric Railways President's Conference Committee, 292 Madison Avenue, New York City.

Press, Jacob Henry, Jr. (J) motor truck bodies, Jacob Press' Sons, 501 West 33rd Street, Chicago.

Pulleyblank, Donald H. (J) Hurricane Aviation Corp., 1931 Antionette, Detroit; (mail) 4218 Buena Vista.

Range, Howard Joseph (A) sales manager, Cochran & Celli, 1100 Eighth Avenue, Oakland, Calif.

Reynolds, Benjamin S. (M) vice-president, Burgess Battery Co., Madison, Wis.

Robertson, Struan F. (A) managing director, Direct Service Stations, Ltd., 400 Front Street West, Toronto, Ont., Canada.

Sanders, Arthur Freeman (F M) engineer, charge of engine department, John Fowler & Co., Ltd., Leeds, England; (mail) 9 Park View Crescent, Roundhay, Leeds 8, England.

Scoville, Curtiss Wilfred (A) automotive engineer, Socony Vacuum Oil Co., Inc., Albany, N. Y.; (mail) 95 Charlotte Street, Burlington, Vt.

Shelton, James S. (J) warrant officer, U. S. Coast Guard, City of Washington.

Sherman, Don W. (M) directing engineer, automotive division, A. O. Smith Corp., Milwaukee.

Smith, H. Perry (A) vice-president, secretary, W. G. B. Oil Clarifier, Inc., Kingston, N. Y.; (mail) Box 248.

Spanogle, John Andrew (M) research engineer, Sterling Engine Co., 1270 Niagara Street, Buffalo, N. Y.

Sperry, Elmer A., Jr. (M) vice-president, chief engineer, Sperry Products, Inc., Sperry Building, Manhattan Bridge Plaza, Brooklyn, N. Y.

Sprague, Gale Alton (M) 1034 Chesterfield Parkway, East Lansing, Mich.

Springer, George A. (J) technical service and sales, Springer-Ott Co., 1026 West Burnside Street, Portland, Ore.

Stern, Richard, Dr. (M) Shell Petroleum Corp., Shell Building, St. Louis, Mo.

Teetsel, A. C. (M) manager, research, Keasbey & Mattison Co., Ambler, Pa.

Urschalitz, Paul E. (A) zone engineer, General Motors Truck Corp., 3925 Vermont Avenue, Detroit.

Wehmeyer, Arthur H. (M) assistant chief engineer, Wisconsin Motor Corp., 1910 South 53rd Street, Milwaukee; (mail) 3147 South Adams Avenue.

Womack, Rich (J) service manager, Ross Motor Co., Multnomah, Ore.; (mail) 3405 Northeast Siskiyon Street, Portland, Ore.

Applications Received

The applications for membership received between June 15, 1935, and July 15, 1935, are listed herewith. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Blair, George W., vice-president, Mishawaka Rubber & Woolen Mfg. Co., Mishawaka, Ind.

Cantelon, W. H., manager, Auto Specialties Manufacturing Co., Windsor, Ont., Canada.

Capwell, Benjamin F., district lubrication manager, Socony-Vacuum Oil Co., New York City.

Ecker, Lyle, engineer, United Parts Manufacturing Co., Chicago, Ill.

Forrest, Edward U., equipment manager, Westcott Hazell & Co., Sydney, Australia.

Gordon, Dwight M., experimental engineer, Carter Carburetor Corp., St. Louis, Mo.

Grant, Robert, superintendent, Final Assembly Department, The Nash Motors Co., Racine, Wis.

Hartley, Herbert, technical officer, Shell Co. of Australia, Sydney, N. S. W., Australia.

Herne, Capt. E. D. C., sales engineer, Chrysler Corp., Detroit, Mich.

Jamieson, Thomas Murray, designer, Austin Motor Co., Ltd., Birmingham, England.

MacMahon, William Howard, chief engineer, Vacuum Oil Co., Ltd., Melbourne, Australia.

McDonald, Neil J., research engineer, Minneapolis-Moline Power Implement Co., Minneapolis, Minn.

Mentzer, W. C., engineer, United Air Lines Transportation Corp., Chicago, Ill.

Okuyoshi, Eiju, research engineer, Tokyo Gas & Electric Co., Omori, Tokyo City, Japan.

Nelson, Gustin MacAllister, instructor, 1st Lieutenant Infantry (tanks), U. S. Army, Fort Benning, Ga.

Pagny, Henri Hubert, technical engineer, Vacuum Oil Co., S.A.F., Paris, France.

Rodger, James Scott, instructor, Department of Education, Victoria, B. C.

Schnee, Vernon H., research chemist, Batelle Memorial Institute, Columbus, Ohio.

Wells, Justin Henry, director, Germ Lubricants Ltd., London, England.

Whitesell, Frank E., sales manager, automotive lubricants, Socony-Vacuum Oil Co., Inc., New York City.

S.A.E. General Meetings for 1935

Production Meeting
Sept. 18 & 19—Hotel Statler, Cleveland

Transportation Meeting
Oct. 10—Palmer House, Chicago

Tractor and Industrial Power Meeting
Oct. 11 & 12—Palmer House, Chicago

S.A.E. Annual Dinner
Nov. 4—New York City

Next Annual Meeting in Detroit, January, 1936. Exact dates to be announced later.

Obituaries

(Continued from page 25)

facture. With the depression Citroën sales dropped off sharply and a heroic effort to recoup losses by remodeling plants and developing models came to naught.

Monsieur Citroën was a frequent visitor to the United States and many times expressed his admiration for the achievements of Henry Ford. He joined the S.A.E. in 1917.

Charles T. Coleman

Charles T. Coleman, well-known transportation engineer who had served with several divisions of the General Motors Corp. since 1924, died June 30 at Washington, D. C. At the time of his death he was connected with the General Motors Truck Co.

In 1918 he enlisted in the Motor Branch of the Quartermaster Corps and was stationed at Camp Holabird. Later was commissioned as a Lieutenant and then a Captain and took a Motor Transportation Unit overseas. After his return to the States in August, 1919, was stationed in the office of the Chief of Motor Transport Corps, and later resigned.

In 1920 he accepted a position with the United States Bureau of Standards in the Powerplant Section dealing with automotive and aviation research work. Was also a member of the Government Specifications Committee on Lubricants and Liquid Fuels.

In 1924 joined General Motors Corp. as field engineer in the railroad service department. Resigned when department was moved to Chicago, in August, 1926. He joined the General Motors Export Division in December, 1926, as assistant to the general sales manager, in charge of truck program.

Orville Hiram Ensign

Orville Hiram Ensign, president, Ensign Carburetor Co., Ltd., Huntington Park, Calif., died June 1. He had been a member of the Society since 1917.

Although he held many patents on automotive devices and was actively interested in the company bearing his name until within four years of the time of his death, Mr. Ensign was perhaps better known as a construction engineer on heavy electrical projects. As early as 1896 he superintended the construction of a 33,000-volt power line from Redlands to Los Angeles, Calif.

And from Canada—

a well-known executive writes:

"Knowledge of my work, of my fellows and of their ideas and ideals, and of the ramifications of this great automotive industry—have flowed freely to me from the SA.E. fountain head for nearly a quarter of a century."

—R. H. Combs, President
Prest-O-Lite Storage Battery Co., Ltd.
Toronto, Ont.

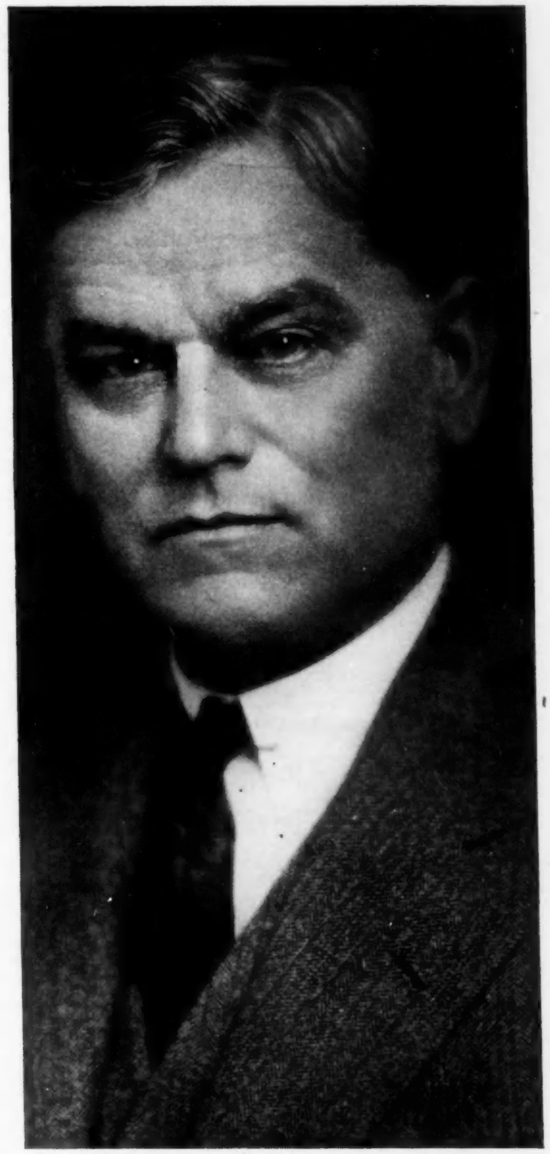


Photo by Milne, Toronto

Mr. COMBS'S opinion is founded on 23 years of experience of the Society's operations, and gains additional weight from his unique service, first as chairman of the Indiana Section and then as first chairman of the Canadian Section, now one of the most flourishing branches of the Society's membership. In 1916, Mr. Combs served the Society as a vice-president of the general organization.

A veteran in the automotive industry, in the Prest-O-Lite organization, and in the Society, Mr. Combs has expressed a thought which the Society is proud to record, believing that it represents in effect, the opinion of a large group of the Society's membership.

30th ANNIVERSARY YEAR · · · 1935

This page is printed for the inspiration of our present members—for presentation to prospective members

Notes and Reviews

THESE items, which are prepared by the Research Department, give brief descriptions of technical books and articles on automotive subjects. As a rule no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

The letters and numbers in brackets following the titles classify the articles into the following divisions and subdivisions: *Divisions*—A, Aircraft; B, Body; C, Chassis Parts; D, Education; E, Engines; F, Highways; G, Material; H, Miscellaneous; I, Motorboat; J, Motorcoach; K, Motor-Truck; L, Passenger Car; M, Tractor. *Subdivisions*—1, Design and Research; 2, Maintenance and Service; 3, Miscellaneous; 4, Operation; 5, Production; 6, Sales.

AIRCRAFT

Aerodynamic Theory Vol. III

By William Frederick Durand. Published by Julius Springer, Berlin. 1935; 354 pp., illustrated. [A-1]

This book is the third in the series covering a general review of progress in this field, prepared under a grant of the Guggenheim Fund for the Promotion of Aeronautics. Volumes I and II have been reviewed previously in these columns.

Volume III treats:

(a) The Theory of Single Burbling, by C. Witoszynski and M. J. Thompson;
(b) The Mechanics of Viscous Fluids, by L. Prandtl;
(c) The Mechanics of Compressible Fluids, by G. I. Taylor and J. W. Maccoll; and
(d) Experimental Methods—Wind Tunnels, by A. Toussaint and E. Jacobs.

Structural Design of Metal Airplanes

By John E. Younger with the assistance of Raymond H. Rice and Nairne F. Ward. Published by McGraw-Hill Book Company, Inc., New York and London, 1935; 344 pp., illustrated. [A-1]

The author contends that the phenomenal progress in airplane design in this country during the last few years has been exclusively in all-metal construction, and of the types of metal construction the trend is toward the general use of thin sheets formed into structural stress members. This book has been prepared to fill the need for a text for college students presenting the basic principles and methods of metal-airplane design. The four sections of the book deal respectively with: The Design Problem, Available Materials, Basic Structural Analysis and Special Problems in the Design of Metal Airplanes.

Metal Aircraft Construction

By M. Langley. Published by Pitman Publishing Corp., New York and London, Second Edition 1934; 338 pp., illustrated. [A-1]

This review for aeronautical engineers of the modern international practice in metal construction of aircraft has been completely revised and enlarged in the second edition.

ENGINES

The Thermodynamics of Combustion in the Otto Cycle Engine

By E. S. Taylor. N.A.C.A. Technical Note. No. 533, June, 1935; 6 pp., 1 fig. [E-1]

Les Moteurs d'Aviation Français en 1935

By Pierre Léglise. Published in *L'Aéronautique*, April, 1935, p. 78. [E-1]

Products of more than a score of French aircraft engine manufacturers are described, emphasis being placed on the most characteristic or novel feature of each. The descriptions are amply illustrated by photographs and original sketches.

Les Recents Progrès des Carburateurs et des Appareils d'Alimentation en Essence

By G. Delanghe. Published in *Le Génie Civil*, March 2, 1935, p. 207. [E-1]

With the impetus of gasoline taxation, recent carburetor design development in France has been toward gasoline economizing expedients. Summarizing such developments, the author treats particularly of auto-

(Concluded on page 34)

NOTES AND REVIEWS

Concluded

matic carburetion regulation, a device for preventing gasoline consumption when a non-freewheeling vehicle is coasting, and fuel pump improvements designed to prevent vapor lock.

Moteurs à Explosion à Compression en 2 Phases

By Paul Dugelay. Published in *Journal de la Société des Ingénieurs de l'Automobile,* February, 1935. [E-1]

The theoretical advantages and operation of an internal-combusion engine with two-stage compression are discussed, the reduction in the temperature of combustion, the increase in compression ratio and the reduction in fuel consumption attainable being particularly emphasized. The design of such an engine is then described. Its performance is said to approach closely the theoretical possibilities set forth.

MATERIAL

Aviation Gasolines Call for Most Complete Specifications

By E. L. Bass. Published in *The Oil and Gas Journal,* June 20, 1935, p. 15. [G-1]

This is an abridged article based on a paper presented at a meeting of the Royal Aeronautical Society, London, entitled: "Fuels for Aircraft Engines."

Dr. Bass discusses specifications for the following properties of aviation gasoline: vapor pressure, freezing point, specific gravity, viscosity, calorific value and impurities. He also considers future developments and the use of iso-octane.

La Question des Carburants

Published in *Journal de la Société des Ingénieurs de l'Automobile,* March, 1935, p. 149. [G-3]

This symposium on current motor fuels consists of four articles dealing respectively with the composition and characteristics of the new Mesopotamian crudes; the production, performance and physiological aspects of ethyl gasolines; the composition and taxation of current commercial French gasolines; and current fuels from the viewpoints of the automobile manufacturer and operator.

L'Evolution de la Semi-Carbonisation et de la Fabrication de Carburants de Synthèse, en France, en Angleterre et en Allemagne

By Ch. Berthelot. Published in *Le Génie Civil,* April 13, 1935, p. 353. [G-5]

A summary is presented of recent developments in low temperature carbonization and the manufacture of synthetic fuels in France, England and Germany.

MISCELLANEOUS

Research—The Pathfinder of Science and Industry

By T. A. Boyd. Published by D. Appleton-Century Company, Inc., New York and London, 1935; 319 pp. [H-1]

Members of the Society acquainted with T. A. Boyd's research work, both for his company and, as a member of various committees, for the Society, will enthusiastically accede his title to speak in this field as one having authority.

In his book, the research man becomes articulate. His activity is defined in its dual aspect, that of a far-flung adventurous quest for "that which can be" and that of a travail of infinite and meticulous labor. The methods and achievements of industrial research are set forth. Especially noteworthy is the thoughtful and original analysis of the charactertistics requisite in a research worker.

To the research worker Mr. Boyd's book brings sympathetic contact with a fellow mind, and, more practically, solid information on the tools of his craft. To the general engineer, it opens up an illuminating vista of advantages to be obtained through research. It will serve as a substantial and friendly guide to the student contemplating research as his niche in industry.

Simply and sincerely written, Mr. Boyd's message reaches his readers directy without circumlocution or excess verbiage. His many quotations from diverse sources show that to his task he has brought the qualification of erudition as well as practical, first hand knowledge.

La Technique du Graissage et l'Insuffisance des Théories Actuelles

By H. Brillé. Published in *Le Génie Civil,* March 23, 1935, p. 282. [H-1]

The author presents certain corrections which in his opinion should be made in the theories of lubrication expounded up to the present, and concludes that in the present state of the art all the elements are available for the formation of a theory more complete and more representative of results actually obtained in practice than any so far developed.

MOTORCOACH

Bus Facts for 1935

Published by the National Association of Motor Bus Operators, City of Washington, 1935; 53 pp. [J-3]

Facts and figures of the motor bus industry as of Jan. 1, 1935 are now available in this booklet which is a compilation of all important statistical information bearing on the industry and which has been brought to light by various individuals, trade publications, and authoritative research agencies during the calendar year of 1934.

PASSENGER CAR

L'Evolution de la Technique Automobile Allemande d'après le Salon de Berlin

By G. Delanghe. Published in *Le Génie Civil,* April 6, 1935, p. 330. [L-1]

A major feature of the German automotive industry is said to be the efficacy of the Governmental measures in favor of national motorization. Not only has design sought new paths, some of which are here discussed, but production has increased. Worthy of consideration, also, are the construction of automobile express highways and efforts made toward the creation of a vast synthetic fuel production utilizing domestic resources.

Le Quatorzième Critérium International de Tourisme Paris-Nice et le Cinquième Rallye de la Fédération Nationale des Automobile-Clubs de France

By Henri Petit. Published in *La Vie Automobile,* May 10, 1935, p. 170. [L-4]

Among the 35 entries in the 14th annual competitive Paris-Nice run, two American makes were represented. The object of this event is to test those qualities which should characterize a good stock passenger-car. Ratings are given on endurance, speed, reliability, acceleration, braking, maneuverability, and hill climbing ability, each of which is made the object of a separate test. An account of the event this year and a report of the results are given.